

## **RELATIVE BIOAVAILABILITY OF LEAD IN SOILS FROM THE VBI70 SITE**

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## EXECUTIVE SUMMARY

A study using young swine as test animals was performed to measure the gastrointestinal absorption of lead in two soils from the Vasquez Boulevard/I-70 site (VB-I70) located in Denver, Colorado. Young swine were selected for use in the study primarily because the gastrointestinal physiology and overall size of young swine are similar to that of young children, who are the population of prime concern for exposure to soil lead.

The test materials were prepared by combining soil samples collected from residential properties within the study area. The soil samples were selected to represent both an Eastern and Western area. The lead concentration in these samples was 723 parts per million (ppm) for test material #1 (Eastern Sample) and 987 ppm for test material #2 (Western Sample). Groups of 5 swine were given average oral doses of 103.7, 311.2 or 691.6 mg/kg-d of test material #1 or 76.0, 228.0, or 506.6 mg/kg-d of test material #2 for 15 days. This corresponded to target average doses of 75, 225, or 500 ug/kg/day of lead. Other groups of animals were given a standard lead reference material (lead acetate) orally at doses of 0, 25, 75, or 225 ug Pb/kg-day. The amount of lead absorbed by each animal was evaluated by measuring the amount of lead in the blood (measured on days 0, 1, 2, 3, 5, 7, 9, 12, and 15), and the amount of lead in liver, kidney and bone (measured on day 15 at study termination). The amount of lead present in blood or tissues of animals exposed to test soils was compared to that for animals exposed to lead acetate, and the results were expressed as relative bioavailability (RBA). For example, a relative bioavailability of 50% means that 50% of the lead in soil was absorbed equally as well as lead from lead acetate, and 50% behaved as if it were not available for absorption. Thus, if lead acetate were 40% absorbed, the test material would be 20% absorbed.

The RBA results for the two samples from the VB-I70 site are summarized below:

Measurement Endpoint	Test Material #1 Eastern Sample	Test Material #2 Western Sample
Blood Lead Area Under Curve	87%	85%
Liver Lead	98%	70%
Kidney Lead	97%	78%
Bone Lead	69%	56%

Because the estimates of RBA based on blood, liver, kidney, and bone do not agree in all cases, judgment must be used in interpreting the data. In general, EPA recommends greatest emphasis be placed on the RBA estimates derived from the blood lead data. This is because blood lead data are more robust and less susceptible to random errors than the tissue lead data, so there is greater confidence in RBA estimates based on blood lead. In addition, absorption into the central compartment is an early indicator of lead exposure, is

the most relevant index of central nervous system exposure, and is the standard measurement endpoint in investigations of this sort. However, data from the tissue endpoints (liver, kidney, bone) also provide valuable information. EPA considers the plausible range to extend from the RBA based on blood AUC to the mean of the other three tissues (liver, kidney, bone). The preferred range is the interval from the RBA based on blood to the mean of the blood RBA and the tissue mean RBA. Our suggested point estimate is the mid-point of the preferred range. These values are presented below:

Relative Bioavailability of Lead	Test Material #1 Eastern Sample	Test Material #2 Western Sample
Plausible Range	87-88%	68-85%
Preferred Range	87-88%	76-85%
Suggested Point Estimate	87%	81%

These RBA estimates may be used to help assess lead risk at this site by refining the estimate of absolute bioavailability (ABA) of lead in soil, as follows:

$$ABA_{\text{soil}} = ABA_{\text{soluble}} * RBA_{\text{soil}}$$

Available data indicate that fully soluble forms of lead are about 50% absorbed by a child. Thus, the estimated absolute bioavailability of lead in the site samples is as follows:

Absolute Bioavailability of Lead	Test Material #1 Eastern Sample	Test Material #2 Western Sample
Plausible Range	43-44%	34-42%
Preferred Range	43-44%	38-42%
Suggested Point Estimate	43%	40%

These absolute bioavailability estimates are appropriate for site-specific use in EPA's IEUBK model, although it is clear that there is both natural variability and uncertainty associated with these estimates. This variability and uncertainty arises from several sources, including: 1) the inherent variability in the responses of different individual animals to lead exposure, 2) uncertainty in the relative accuracy and applicability of the different measurement endpoints, 3) the extrapolation of measured RBA values in swine to young children, and 4) the potential effect of food in the stomach on lead absorption. Thus, the values reported above are judged to be reasonable estimates of typical lead absorption by children at this site, but should be interpreted with the understanding that the values are not certain.

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## 1.0 INTRODUCTION

### Absolute and Relative Bioavailability

Bioavailability is a concept that relates to the absorption of chemicals and how absorption depends upon the physical-chemical properties of the chemical and its medium (e.g., dust, soil, rock, food, water, etc.) and the physiology of the exposed receptor. Bioavailability is normally described as the fraction (or percentage) of a chemical which enters into the blood following an exposure of some specified amount, duration and route (usually oral). In some cases, bioavailability may be measured using chemical levels in peripheral tissues such as liver, kidney, and bone, rather than blood. The fraction or percentage absorbed may be expressed either in absolute terms (absolute bioavailability, ABA) or in relative terms (relative bioavailability, RBA). **Absolute bioavailability** is measured by comparing the amount of chemical entering the blood (or other tissue) following oral exposure to test material with the amount entering the blood (or other tissue) following intravenous exposure to an equal amount of some dissolved form of the chemical. Similarly, **relative bioavailability** is measured by comparing oral absorption of test material to oral absorption of some fully soluble form of the chemical (e.g., either the chemical dissolved in water, or a solid form that is expected to fully dissolve in the stomach). For example, if 100 ug of dissolved lead were administered in drinking water and a total of 50 ug entered the blood, the ABA would be 0.50 (50%). Likewise, if 100 ug of lead in soil were administered and 30 ug entered the blood, the ABA for soil would be 0.30 (30%). If the lead dissolved in water were used as the reference substance for describing the relative amount of lead absorbed from soil, the RBA would be  $0.30/0.50 = 0.60$  (60%). These values (50% absolute bioavailability of dissolved lead and 30% absolute absorption of lead in soil) are the values currently employed as defaults in EPA's IEUBK model.

It is important to recognize that simple solubility of a test material in water or some other fluid (e.g., a weak acid intended to mimic the gastric contents of a child) may not be a reliable estimator of bioavailability due to the non-equilibrium nature of the dissolution and transport processes that occur in the gastrointestinal tract (Mushak 1991). For example, fluid volume and pH are likely to be changing as a function of time, and transport of lead across the gut will prevent an approach to equilibrium concentrations, especially for poorly soluble lead compounds. However, information on the solubility of lead in different materials is useful in interpreting the importance of solubility as a determinant of bioavailability. To avoid confusion, the term "bioaccessability" is used to refer to the relative amount of lead that dissolves under a specified set of test conditions.

For additional discussion about the concept and application of bioavailability see Goodman et al. (1990), Klaassen et al. (1996), and/or Gibaldi and Perrier (1982).

## Using Bioavailability Data to Improve Exposure Calculations for Lead

When data are available on the bioavailability of lead in soil, dust, or other soil-like waste material at a site, this information can often be used to improve the accuracy of exposure and risk calculations at that site. The basic equation for estimating the site-specific ABA of a test soil is as follows:

$$ABA_{\text{soil}} = ABA_{\text{soluble}} \cdot RBA_{\text{soil}}$$

where:

$ABA_{\text{soil}}$	=	Absolute bioavailability of lead in soil ingested by a child
$ABA_{\text{soluble}}$	=	Absolute bioavailability in children of some dissolved or fully soluble form of lead
$RBA_{\text{soil}}$	=	RBA for soil measured in swine

Based on available information on lead absorption in humans and animals, the EPA estimates that the absolute bioavailability of lead from water and other fully soluble forms of lead is usually about 50% in children. Thus, when a reliable site-specific RBA value for soil is available, it may be used to estimate a site-specific absolute bioavailability as follows:

$$ABA_{\text{soil}} = 50\% \cdot RBA_{\text{soil}}$$

In the absence of site-specific data, the absolute absorption of lead from soil, dust and other similar media is estimated by EPA to be about 30%. Thus, the default RBA used by EPA for lead in soil and dust compared to lead in water is  $30\%/50\% = 60\%$ . When the measured RBA in soil or dust at a site is found to be less than 60% compared to some fully soluble form of lead, it may be concluded that exposures to and risks from lead in these media at that site are probably lower than typical default assumptions. If the measured RBA is higher than 60%, absorption of and risk from lead in these media may be higher than usually assumed.

## 2.0 STUDY DESIGN

A standardized study protocol for measuring absolute and relative bioavailability of lead was developed based upon previous study designs and investigations that characterized the young pig model (Weis et al. 1995). The study was performed as nearly as possible within the spirit and guidelines of Good Laboratory Practices (GLP: 40 CFR 792). Standard Operating Procedures (SOPs) that included detailed methods for all aspects of the study were prepared, approved, and distributed to all study members prior to the study (USEPA 2000).

### 2.1 Test Materials

Soil samples were collected from various residential properties within the VBI70 site which were selected for specific concentrations of lead and arsenic (Washington Group, 2000; attached as appendix B). The two soils were prepared to represent both Eastern (Test Material #1) and Western (Test Material #2) neighborhoods within this site. Six individual soil samples were combined to make the Eastern sample, and five individual soil samples were combined to make the Western sample. Each sample was dried in a laboratory oven at 105 C, bulk sieved with a 2-mm screen and fine sieved with a 250-µm screen. Further details regarding the selection and preparation of test materials can be found in a separate technical memorandum (Washington Group, 2000).

Table 2-1 summarizes the lead and arsenic content of the test soils measured using ICP method SW6010. As seen, average lead concentrations in the Eastern and Western Test Materials are 723 and 987 mg/kg, respectively.

**TABLE 2-1 LEAD AND ARSENIC ANALYSIS OF TEST MATERIALS**

Sample	Replicate	Arsenic (mg/kg)	Lead (mg/kg)
Eastern Sample (TM#1)	#1	19	700
	#2	19	710
	#3	20	760
	Average	19	723
Western Sample (TM#2)	#1	26	970
	#2	25	1000
	#3	24	990
	Average	25	987

Each sample of test material was well mixed and analyzed by electron microprobe in order to identify a) how frequently particles of various lead minerals were observed, b) how frequently different types of mineral particles occur entirely inside particles of rock or slag ("included") and how often they occur partially or entirely outside rock or slag particles ("liberated"), c) the size distribution of particles of each mineral class, and d) approximately how much of the total amount of lead in the sample occurs in each mineral type. This is referred to as "relative lead mass". The results are summarized in Figures 2-1 to 2-3.

As seen in Figure 2-1 (top panel), the most common lead-bearing particle type (i.e., those which are observed most often) for the Eastern Sample (Test Material #1) was Iron Oxide, accounting for about 34% of all lead-bearing particles. However, as shown in Figure 2-2 (upper panel), because the concentration of lead in iron oxide is relatively low, this phase accounted for only about 7.3% of the lead mass in this sample. The remainder of the lead in the eastern sample occurred mainly in particles of phosphate (41.4%), anglesite (15.6%) and paint (12%). Also shown in Figure 2-1 (bottom panel) are the results for the Western Sample (Test Material #2). As seen, the most common lead-bearing particle types were slag, phosphate, organics and iron oxide, accounting for about 18.3%, 17.5%, 18.8% and 16.7% of all lead-bearing particles, respectively. The majority of lead mass (Figure 2-2, bottom panel) in this sample was found in the phosphate (52.7%) and cerussite (18.3%) phases.

Figure 2-3 shows the distribution of the size of lead-bearing particles in the sample. As seen, there was a fairly broad distribution of lead-bearing particle sizes in both test materials, mainly ranging from 50-200  $\mu\text{m}$ . As noted above, small particles are often assumed to be more likely to adhere to the hand and be ingested and/or transported into the house. Further, small particles have larger surface area-to-volume ratios than larger particles, and so may tend to dissolve more rapidly in the acidic contents of the stomach than larger particles. Thus, small particle (e.g., less than 50-100  $\mu\text{m}$ ) are thought to be of greater potential concern to humans than larger particles (e.g., 100 -250  $\mu\text{m}$  or larger).

Another property of lead particles that may be important in determining bioaccessability and/or bioavailability is the degree to which they are partially or entirely free from surrounding matrix ("liberated"). Based on the measured frequency of each type of particle existing in a liberated state, it can be calculated that of the total relative lead present in the samples, about 97.2% exists in liberated particles in the Eastern Sample (TM1) and 95.5% exists in liberated particles in the Western Sample (TM2). These high percentages of partially or entirely liberated grains may tend to increase the bioavailability of lead in the samples.

**FIGURE 2-1 FREQUENCY OF LEAD PARTICLES**

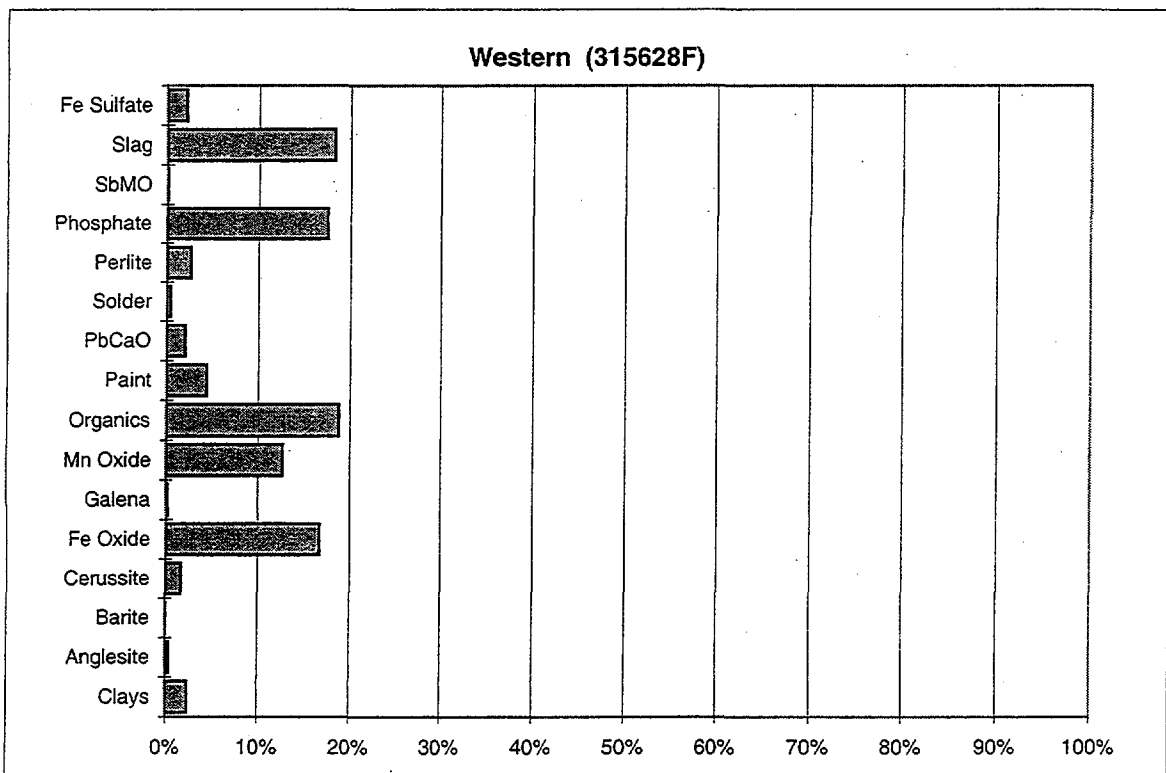
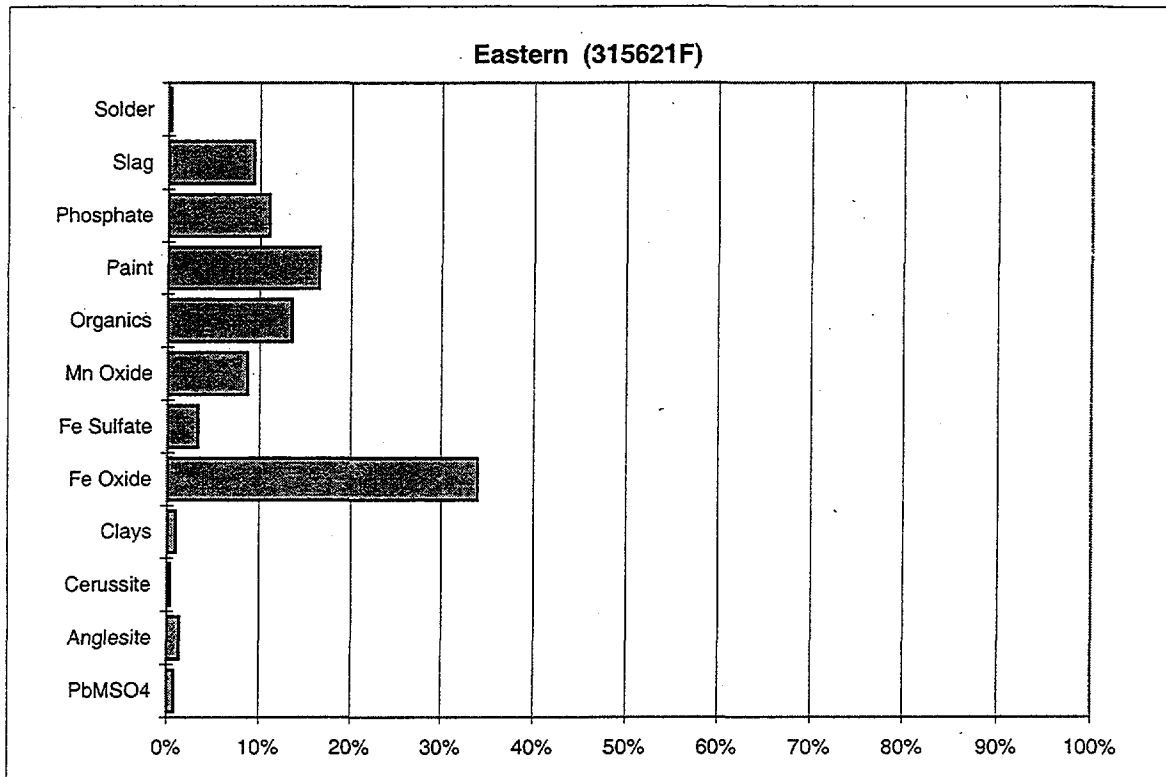
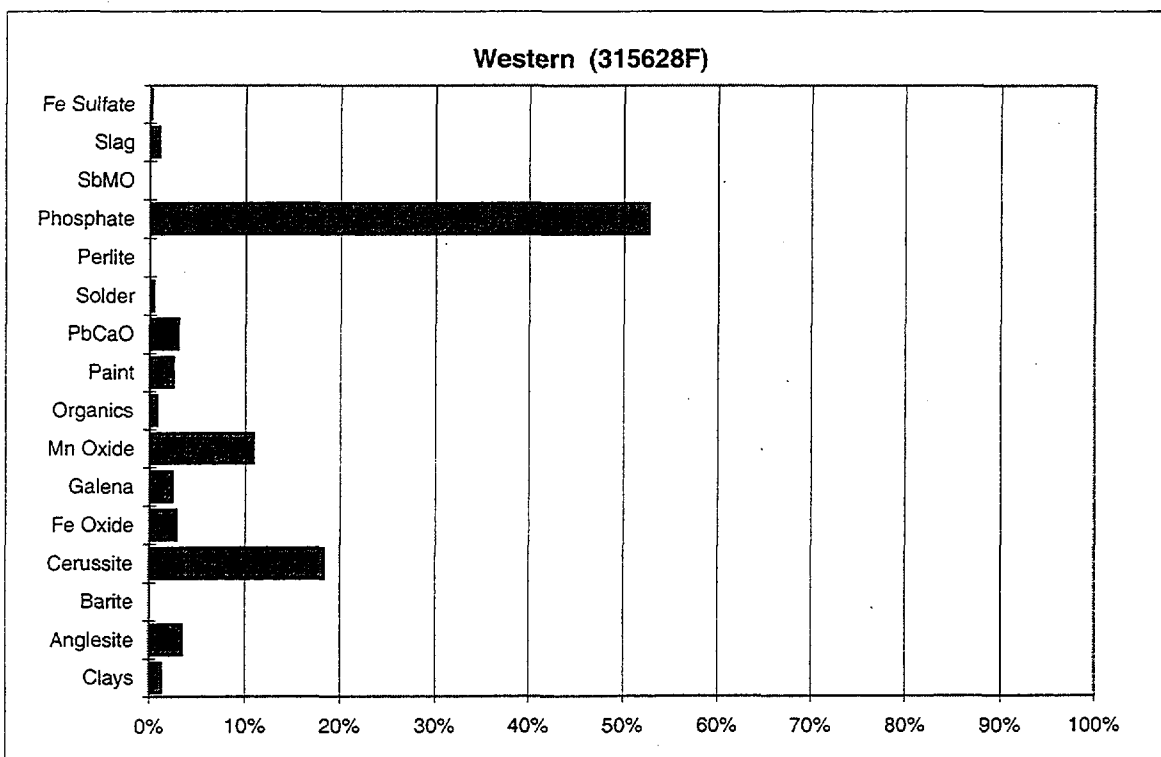
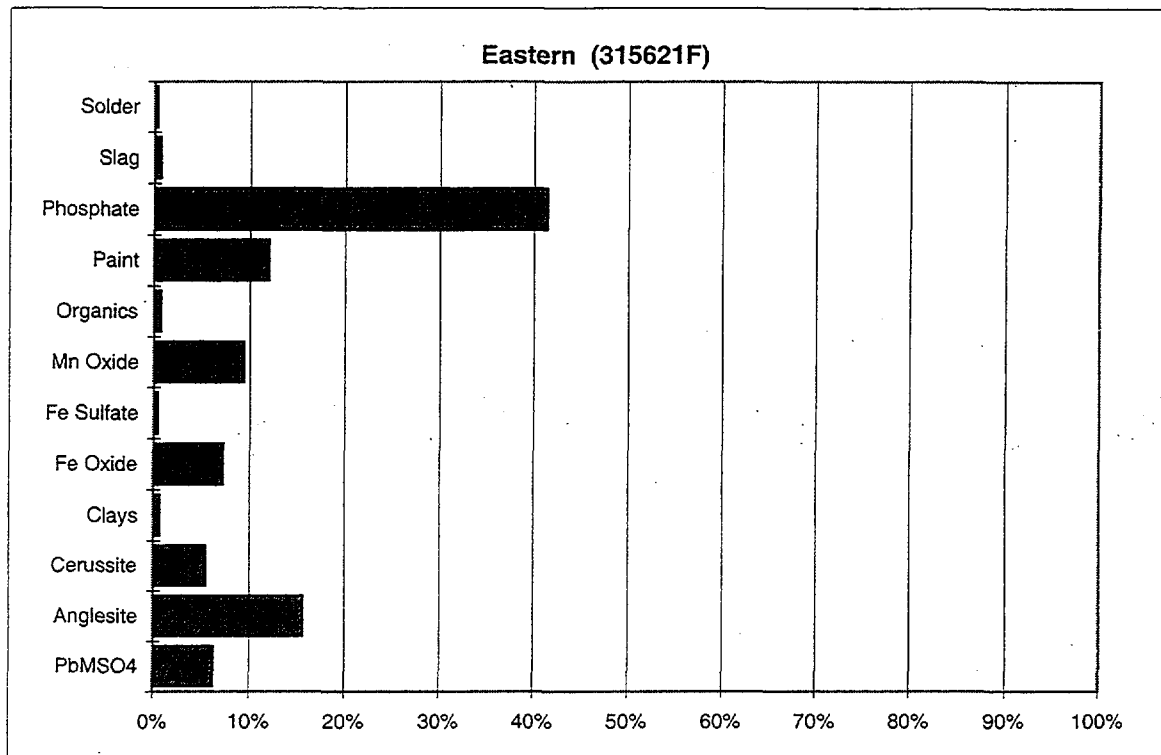
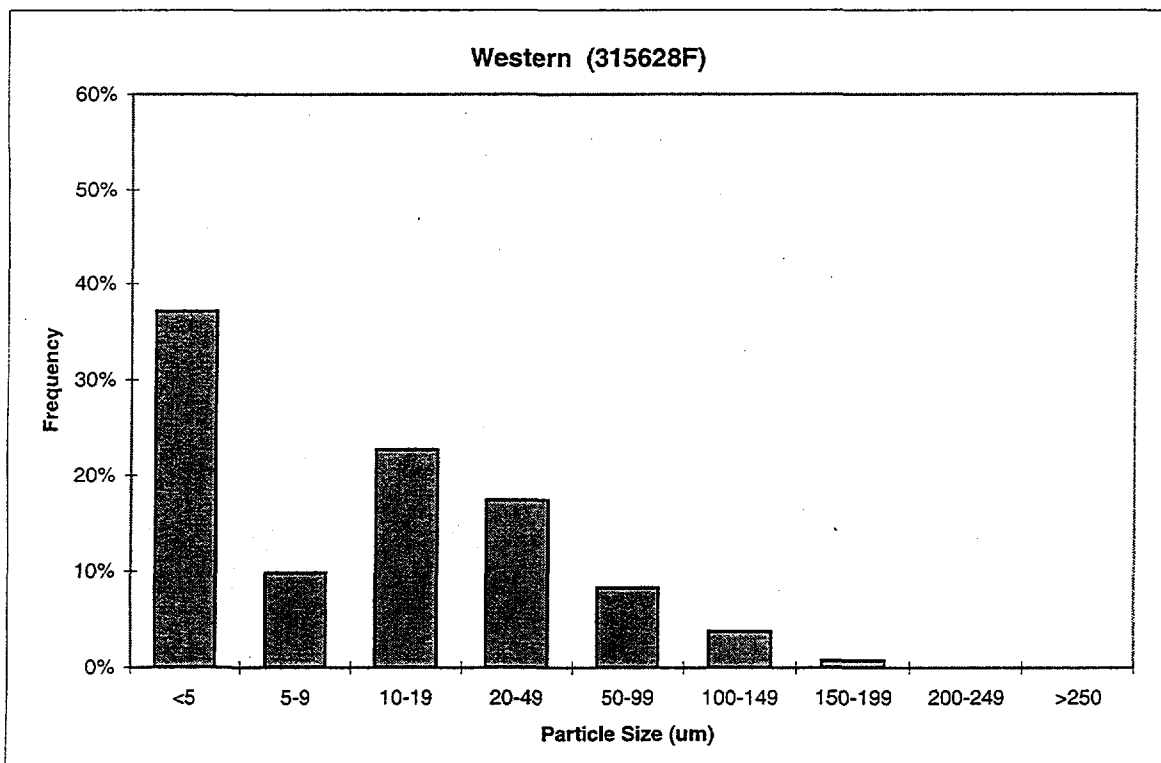
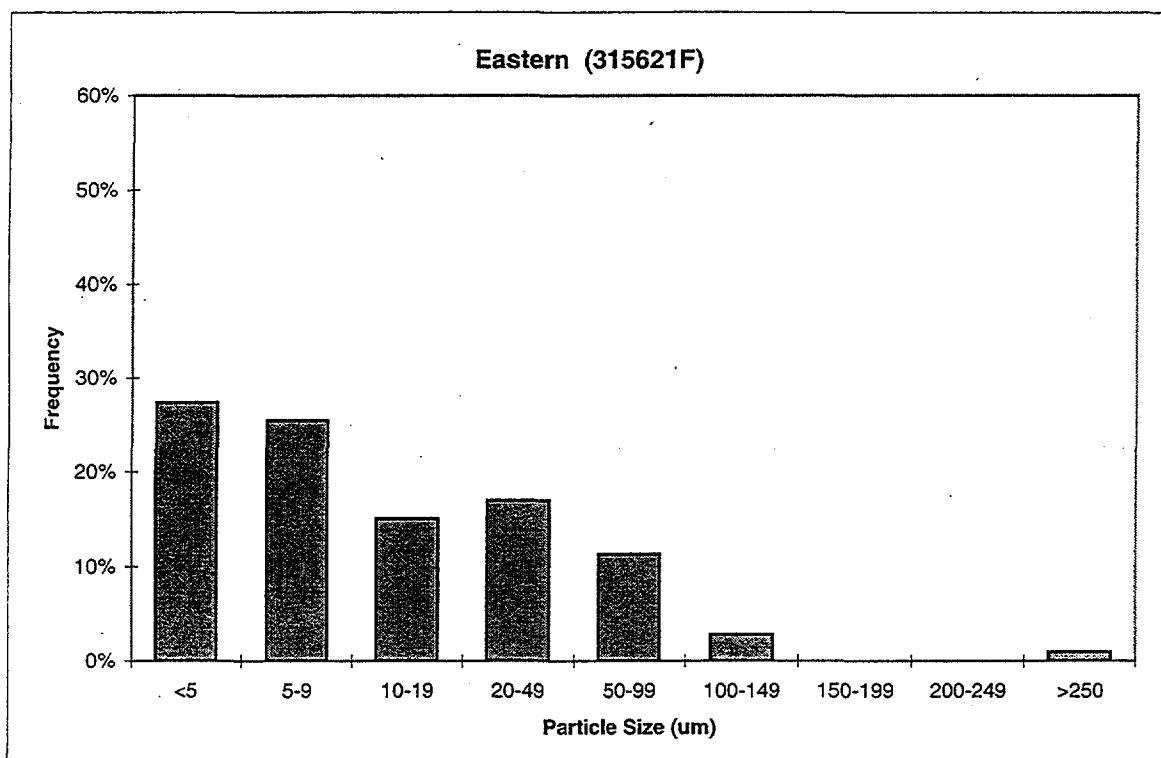


FIGURE 2-2 LEAD MASS



**FIGURE 2-3 PARTICLE SIZE DISTRIBUTION**



## 2.2 Experimental Animals

Young swine were selected for use in these studies because they are considered to be a good physiological model for gastrointestinal absorption in children (Weis and LaVelle 1991). The animals were intact males of the Pig Improvement Corporation (PIC) genetically defined Line 26, and were purchased from Chinn Farms, Clarence, MO. The animals were held under quarantine to observe their health for one week before beginning exposure to test materials. To minimize weight variations between animals and groups, the number of animals purchased from the supplier was six more than needed for the study, and the six animals most different in body weight on day -4 (either heavier or lighter) were excluded from further study. The remaining animals were assigned to dose groups at random. When exposure began (day zero), the animals were about 5-6 weeks old (juveniles, weaned at 3 weeks) and weighed an average of about 9.7 kg. Animals were weighed every three days during the course of the study. The group mean body weights over the course of the study are shown in Figure 2-4. On average, animals gained about 0.5 kg/day, and the rate of weight gain was comparable in all groups.

All animals were housed in individual lead-free stainless steel cages. Each animal was examined by a certified veterinary clinician (swine specialist) prior to being placed on study, and all animals were examined daily by an attending veterinarian while on study. Blood samples were collected for hematological analysis on days -4, 7, and 15 to assist in clinical health assessments. In this study, there was one animal that was removed from the study due to concerns over poor health.

## 2.3 Diet

Animals provided by the supplier were weaned onto standard pig chow purchased from MFA Inc., Columbia, MO. In order to minimize lead exposure from the diet, the animals were gradually transitioned from the MFA feed to a special low-lead feed (guaranteed less than 0.2 ppm lead, purchased from Zeigler Brothers, Inc., Gardners, PA) over the time interval from day -7 to day -3, and this feed was then maintained for the duration of the study. The feed was nutritionally complete and met all requirements of the National Institutes of Health-National Research Council. The typical nutritional components and chemical analysis of the feed is presented in Table 2-2. Typically, the feed contained approximately 5.7% moisture, 1.7% fiber, and provided about 3.4 kcal of metabolizable energy per gram. Analysis of two feed samples during this experiment indicated the mean lead level was 0.15 ppm.

Each day every animal was given an amount of feed equal to 5% of the mean body weight of all animals on study. Feed was administered in two equal portions of 2.5% of the mean body weight at each feeding. Feed was provided at 11:00 AM and 5:00 PM daily. Drinking water was provided ad libitum via self-activated watering nozzles within each cage. Analysis of samples from randomly selected drinking water nozzles indicated the mean lead concentration (treating non-detects at one-half the quantitation limit) was less than 1 ug/L.

**FIGURE 2-4 BODY WEIGHTS OF TEST ANIMALS**

**VBI70 LEAD INVESTIGATION**

The graph displays the average weight in kilograms for ten different groups of test animals over a period of 16 study days. The y-axis, labeled 'Average Weight (kg)', ranges from 7 to 17. The x-axis, labeled 'Study Day', ranges from -2 to 16. All groups start at approximately 9 kg on day -2. Groups 1 through 5 show a steady increase in weight, reaching between 13.5 kg and 15.5 kg by day 16. Groups 6 through 10 remain relatively stable, ending between 10.5 kg and 12.5 kg. A legend box in the upper right corner identifies each group by its line style and marker.

Group	Day -2	Day 2	Day 4	Day 8	Day 10	Day 12	Day 14	Day 16
Grp 1	9.0	10.0	10.5	11.5	12.5	13.5	14.5	15.5
Grp 2	9.0	10.0	10.5	11.5	12.5	13.5	14.5	15.5
Grp 3	9.0	10.0	10.5	11.5	12.5	13.5	14.5	15.5
Grp 4	9.0	10.0	10.5	11.5	12.5	13.5	14.5	15.5
Grp 5	9.0	10.0	10.5	11.5	12.5	13.5	14.5	15.5
Grp 6	9.0	10.0	10.5	11.0	11.5	11.5	11.5	11.5
Grp 7	9.0	10.0	10.5	11.0	11.5	11.5	11.5	11.5
Grp 8	9.0	10.0	10.5	11.0	11.5	11.5	11.5	11.5
Grp 9	9.0	10.0	10.5	11.0	11.5	11.5	11.5	11.5
Grp 10	9.0	10.0	10.5	11.0	11.5	11.5	11.5	11.5

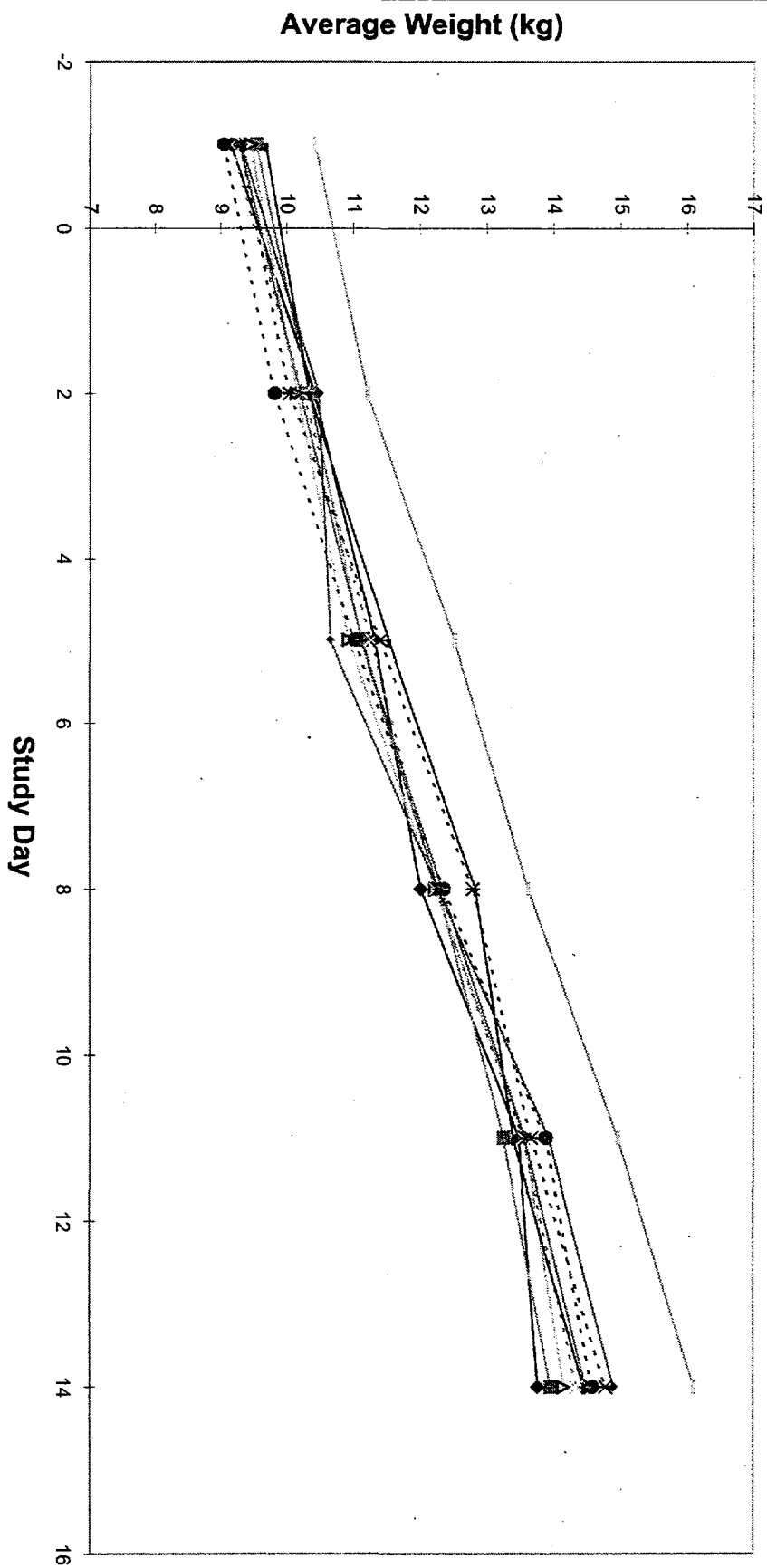


TABLE 2-2 TYPICAL FEED COMPOSITION<sup>a</sup>

Nutrient Name	Amount	Nutrient Name	Amount
Protein	20.1021%	Chlorine	0.1911%
Arginine	1.2070%	Magnesium	0.0533%
Lysine	1.4690%	Sulfur	0.0339%
Methionine	0.8370%	Manganese	20.4719 ppm
Met+Cys	0.5876%	Zinc	118.0608 ppm
Tryptophan	0.2770%	Iron	135.3710 ppm
Histidine	0.5580%	Copper	8.1062 ppm
Leucine	1.8160%	Cobalt	0.0110 ppm
Isoleucine	1.1310%	Iodine	0.2075 ppm
Phenylalanine	1.1050%	Selenium	0.3196 ppm
Phe+Tyr	2.0500%	Nitrogen Free Extract	60.2340%
Threonine	0.8200%	Vitamin A	5.1892 kIU/kg
Valine	1.1910%	Vitamin D3	0.6486 kIU/kg
Fat	4.4440%	Vitamin E	87.2080 IU/kg
Saturated Fat	0.5590%	Vitamin K	0.9089 ppm
Unsaturated Fat	3.7410%	Thiamine	9.1681 ppm
Linoleic 18:2:6	1.9350%	Riboflavin	10.2290 ppm
Linoleic 18:3:3	0.0430%	Niacin	30.1147 ppm
Crude Fiber	3.8035%	Pantothenic Acid	19.1250 ppm
Ash	4.3347%	Choline	1019.8600 ppm
Calcium	0.8675%	Pyridoxine	8.2302 ppm
Phos Total	0.7736%	Folacin	2.0476 ppm
Available Phosphorous	0.7005%	Biotin	0.2038 ppm
Sodium	0.2448%	Vitamin B12	23.4416 ppm
Potassium	0.3733%		

<sup>a</sup> Nutritional values provided by Zeigler Bros., Inc.

## 2.4 Dosing

The protocol for exposing animals to lead is shown in Table 2-3. The dose levels for lead acetate were based on experience from previous swine investigations that showed that doses of 25-225 ug Pb/kg/day gave clear and measurable increases in lead levels in all endpoints measured (blood, liver, kidney, bone). The doses of test materials were set at the same level as lead acetate, with one higher dose (500 ug Pb/kg-day) included in case the test materials were found to yield very low responses.

Animals were exposed to lead acetate or test material for 15 days, with the dose for each day being administered in two equal portions given at 9:00 AM and 3:00 PM (two hours before feeding). Doses were based on measured group mean body weights, and were adjusted every three days to account for animal growth. For animals exposed by the oral route, dose material was placed in the center of a small portion (about 5 grams) of moistened feed, and this was administered to the animals by hand. In this study, all doses were consumed by the animals without delay or spillage. However, on day 3, one animal in Group 8 was inadvertently given a dose for Group 9 in addition to its own dose during the morning dosing. This dosing discrepancy was accounted for in further calculations.

Actual mean doses, calculated from the administered doses and the measured body weights, are also shown in Table 2-3.

## 2.5 Collection of Biological Samples

Samples of blood were collected from each animal on the first day of exposure (day 0), and on days 1, 2, 3, 5, 7, 9, 12, and 15 following the start of exposure. All blood samples were collected by vena-puncture of the anterior vena cava, and samples were immediately placed in purple-top Vacutainer® tubes containing EDTA as anticoagulant. Although EDTA is a chelator of metals, its presence in the sampling tubes will not impact the analytical results for lead. This is because the nitric acid digest used in the analysis destroys the organic constituents in the blood, thereby freeing all lead for analysis. Blood samples were collected each sampling day beginning at 8:00 AM, approximately one hour before the first of the two daily exposures to lead on the sampling day and 17 hours after the last lead exposure the previous day. This blood collection time was selected because the rate of change in blood lead resulting from the preceding exposures is expected to be relatively small after this interval (LaVelle et al. 1991, Weis et al. 1993), so the exact timing of sample collection relative to last dosing is not likely to be critical.

Following collection of the final blood sample at 8:00 AM on day 15, all animals were humanely euthanized and samples of liver, kidney and bone (the right femur) were removed and stored in lead-free plastic bags for lead analysis. Samples of all biological samples collected were archived in order to allow for reanalysis and verification of lead levels, if needed. All animals were also subjected to detailed examination at necropsy by a certified veterinary pathologist in order to assess overall animal health.

TABLE 2-3 DOSING PROTOCOL

Group	Number of Animals	Dose Material Administered	Exposure Route	Lead Dose (ug Pb/kg-d)	
				Target	Actual <sup>a</sup>
1	5	Lead Acetate	Oral	25	26.0
2	5	Lead Acetate	Oral	75	78.0
3	5	Lead Acetate	Oral	225	233.1
4	5	Eastern Sample (TM#1)	Oral	75	77.2
5	5	Eastern Sample (TM#1)	Oral	225	232.0
6	5	Eastern Sample (TM#1)	Oral	500	513.1
7	5	Western Sample (TM#2)	Oral	75	77.1
8	5	Western Sample (TM#2)	Oral	225	236.3
9	5	Western Sample (TM#2)	Oral	500	511.5
10	3 <sup>b</sup>	Control	Oral	0	0

Doses were administered in two equal portions given at 9:00 AM and 3:00 PM each day. Doses were based on the mean weight of the animals in each group, and were adjusted every three days to account for weight gain.

<sup>a</sup> Calculated as the administered daily dose divided by the measured or extrapolated daily body weight, averaged over days 0-14 for each animal and each group.

<sup>b</sup> Three control animals were used in this study due to constraints on facility size. Based on previous investigations, this approach resulted in reliable results.

## 2.6 Preparation of Biological Samples for Analysis

### Blood

One mL of whole blood was removed from the purple-top Vacutainer and added to 9.0 mL of "matrix modifier", a solution recommended by the Centers for Disease Control and Prevention (CDCP) for analysis of blood samples for lead. The composition of matrix modifier is 0.2% (v/v) ultrapure nitric acid, 0.5% (v/v) Triton X-100, and 0.2% (w/v) dibasic ammonium phosphate in deionized and ultrafiltered water. Samples of the matrix modifier were routinely analyzed for lead to ensure the absence of lead contamination.

### Liver and Kidney

One gram of soft tissue (liver or kidney) was placed in a lead-free screw-cap teflon container with 2 mL of concentrated (70%) nitric acid and heated in an oven to 90°C overnight. After cooling, the digestate was transferred to a clean lead-free 10 mL volumetric flask and diluted to volume with deionized and ultrafiltered water.

### Bone

The right femur of each animal was removed and defleshed, and dried at 100°C overnight. The dried bones were then placed in a muffle furnace and dry-ashed at 450°C for 48 hours. Following dry ashing, the bone was ground to a fine powder using a lead-free mortar and pestle, and 200 mg was removed and dissolved in 10.0 mL of 1:1 (v:v) concentrated nitric acid/water. After the powdered bone was dissolved and mixed, 1.0 mL of the acid solution was removed and diluted to 10.0 mL by addition of 0.1% (w/v) lanthanum oxide ( $\text{La}_2\text{O}_3$ ) in deionized and ultrafiltered water.

## 2.7 Lead Analysis

Samples of biological tissue (blood, liver, kidney, bone) and other materials (food, water, reagents and solutions, etc.) were arranged in a random sequence and provided to the analytical laboratory in a blind fashion (identified to the laboratory only by a chain of custody tag number). Each sample was analyzed for lead using a Perkin Elmer Model 5100 graphite furnace atomic absorption spectrophotometer. Internal quality assurance samples were run every tenth sample, and the instrument was recalibrated every 15th sample. A blank, duplicate and spiked sample were run every 20th sample.

All results from the analytical laboratory were reported in units of  $\mu\text{g Pb/L}$  of prepared sample. The quantitation limit was defined as three-times the standard deviation of a set of seven replicates of a low-lead sample (typically about 2-5  $\mu\text{g/L}$ ). The standard deviation was usually about 0.3  $\mu\text{g/L}$ , so the quantitation limit was usually about 0.9-1.0  $\mu\text{g/L}$  (ppb). For prepared blood samples (diluted 1/10), this corresponds to a quantitation limit of 10  $\mu\text{g/L}$  (1  $\mu\text{g/dL}$ ). For soft tissues (liver and kidney, diluted 1/10), this corresponds to a

quantitation limit of 10 ug/kg (ppb) wet weight, and for bone (final dilution = 1/500) the corresponding quantitation limit is 0.5 ug/g (ppm) ashed weight.

### 3.0 DATA ANALYSIS

#### 3.1 Overview

Studies on the absorption of lead are often complicated because some biological responses to lead exposure may be non-linear functions of dose (i.e., tending to flatten out or plateau as dose increases). The cause of this non-linearity is uncertain but might be due either to non-linear **absorption kinetics** and/or to non-linear **biological response** per unit dose absorbed. When the dose-response curve for either the reference material (lead acetate) and/or the test material is non-linear, RBA is equal to the ratio of doses that produce equal responses (not the ratio of responses at equal doses). This is based on the simple but biologically plausible assumption that equal absorbed doses yield equal biological responses. Applying this assumption leads to the following general methods for calculating RBA from a set of non-linear experimental data:

1. Plot the biological responses of individual animals exposed to a series of oral doses of soluble lead (e.g., lead acetate). Fit an equation which gives a smooth line through the observed data points.
2. Plot the biological responses of individual animals exposed to a series of doses of test material. Fit an equation which gives a smooth line through the observed data.
3. Using the best fit equations for reference material and test material, calculate RBA as the ratios of doses of test material and reference material which yield equal biological responses. Depending on the relative shape of the best-fit lines through the lead acetate and test material dose response curves, RBA may either be constant (dose-independent) or variable (dose-dependent).

The principal advantage of this approach is that it is not necessary to understand the basis for a non-linear dose response curve (non-linear absorption and/or non-linear biological response) in order to derive valid RBA estimates. Also, it is important to realize that this method is very general, as it will yield correct results even if one or both of the dose-response curves are linear. In the case where both curves are linear, RBA is dose-independent and is simply equal to the ratio of the slopes of the best-fit linear equations.

#### 3.2 Fitting the Curves

There are a number of different mathematical equations which can yield reasonable fits with the dose-response data sets obtained in this study. Conceptually, any equation which gives a smooth fit would be acceptable, since the main purpose is to allow for interpolation of responses between test doses. In selecting which equations to employ, the following principles were applied: 1) mathematically simple equations were preferred over mathematically complex equations, 2) the shape of the curves had to be smooth and

biologically realistic, without inflection points, maxima or minima, and 3) the general form of the equations had to be able to fit data not only from this one study, but from all the studies that are part of this project. After testing a wide variety of different equations, it was found that all data sets could be well fitted using one of the following three forms:

Linear (LIN): Response =  $a + b \cdot \text{Dose}$

Exponential (EXP): Response =  $a + c \cdot (1 - \exp(-d \cdot \text{Dose}))$

Combination (LIN+EXP): Response =  $a + b \cdot \text{Dose} + c \cdot (1 - \exp(-d \cdot \text{Dose}))$

Although underlying mechanism was not considered in selecting these equations, the linear equation allows fitting data that do not show evidence of saturation in either uptake or response, while the exponential and mixed equations allow evaluation of data that appear to reflect some degree of saturation in uptake and/or response.

Each dose-response data set was fit to each of the equations above. If one equation yielded a fit that was clearly superior (as judged by the value of the adjusted correlation coefficient  $R^2$ ) to the others, that equation was selected. If two or more models fit the data approximately equally well, then the simplest model (that with the fewest parameters) was selected. In the process of finding the best-fits of these equations to the data, the values of the parameters (a, b, c, and d) were subjected to some constraints, and some data points (those that were outside the 95% prediction limits of the fit) were excluded. These constraints and outlier exclusion steps are detailed in Appendix A (Section 3). In general, most blood lead AUC dose-response curves were best fit by the exponential equation, and most dose-response curves for liver, kidney and bone were best fit by linear equations. In evaluating spleen results, it was determined that data were best fit by the exponential equation.

### **3.3 Responses Below Quantitation Limit**

In some cases, most or all of the responses in a group of animals were below the quantitation limit for the endpoint being measured. For example, this was normally the case for blood lead values in unexposed animals (both on day -4 and day 0), and in control animals. In these cases, samples were assigned a response equal to one-half the quantitation limit.

### **3.4 Quality Assurance**

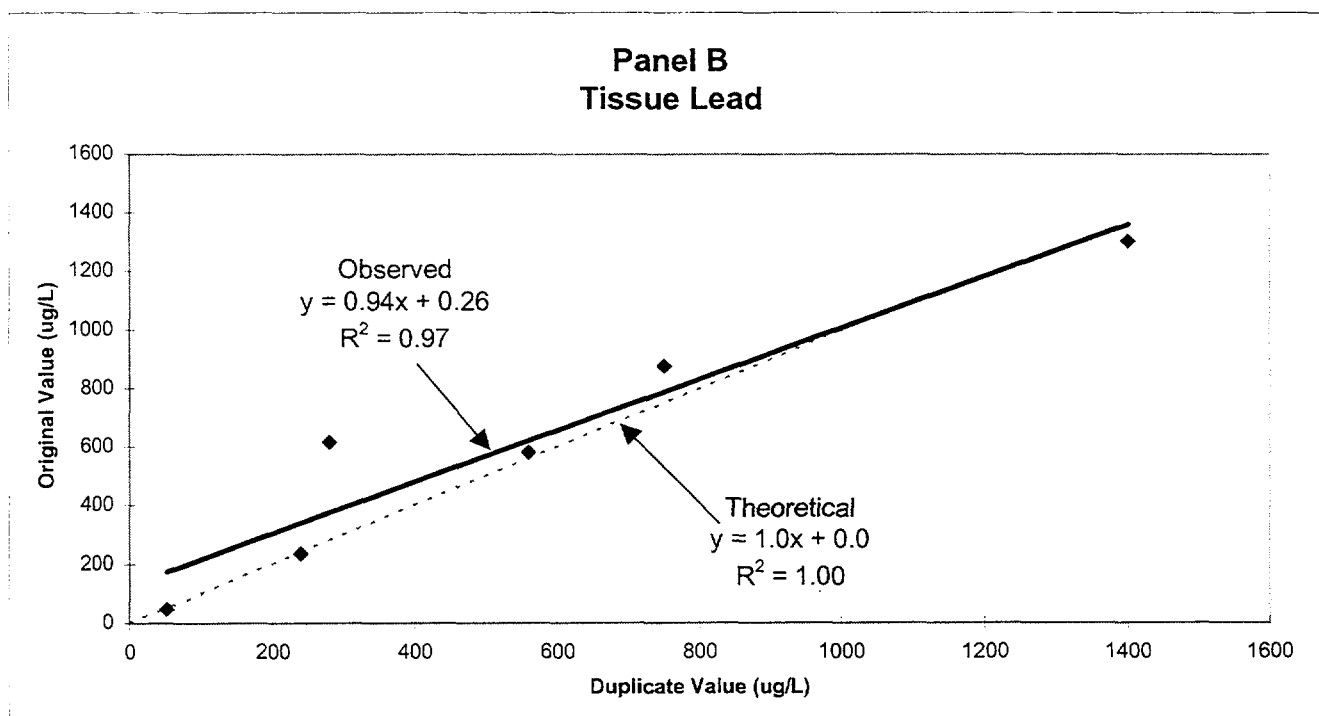
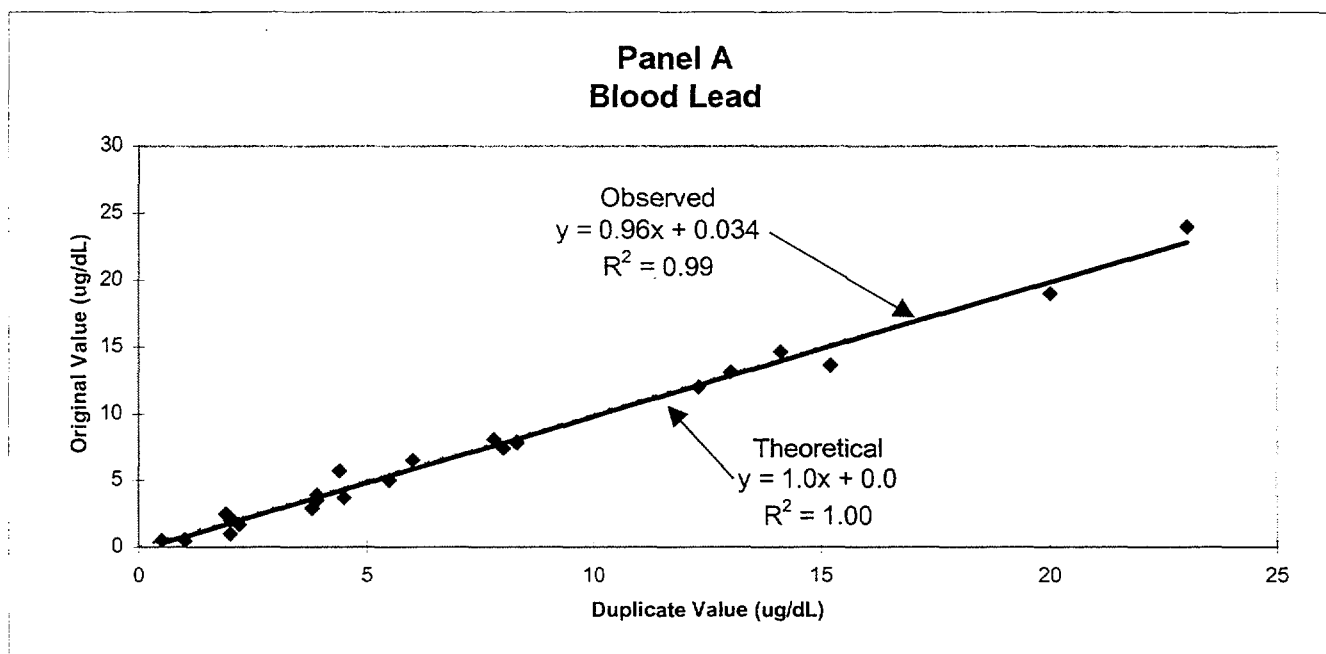
A number of steps were taken throughout this study and the other studies in this project to ensure the quality of the results. These steps are summarized below.

### Duplicates

A randomly selected set of about 5% of all samples generated during the study were submitted to the laboratory in a blind fashion for duplicate analysis. The raw data are presented in Appendix A, and Figure 3-1 plots the results for blood (Panel A, upper) and for bone, liver, and kidney (Panel B, lower).

FIGURE 3-1 COMPARISON OF DUPLICATE ANALYSES

VBI70 LEAD



As seen, there was good intra-laboratory reproducibility between duplicate samples for both blood and tissues, with linear regression lines having a slope near 1.0, an intercept near zero, and an  $R^2$  value near 1.0. One blood sample (not represented in the graph) was determined to be an outlier (original value 6.5; duplicate value 28.7).

### Standards

The Centers for Disease Control and Prevention (CDCP) provides a variety of blood lead "check samples" for use in quality assurance programs for blood lead studies. Each time a group of blood samples was prepared and sent to the laboratory for analysis, several CDCP check samples of different concentrations were included in random order and in a blind fashion.

The results for the samples submitted during this study are presented in Appendix A, and the values are plotted in Figure 3-2. For the "low" standard (nominal = 1.7 ug/dL), the average measured value was 2.0 ug/dL. For the "medium" and "high" standards, the means of the measured values were 3.7 ug/dL (nominal = 4.8 ug/dL) and 13.6 ug/dL (nominal = 14.9 ug/dL).

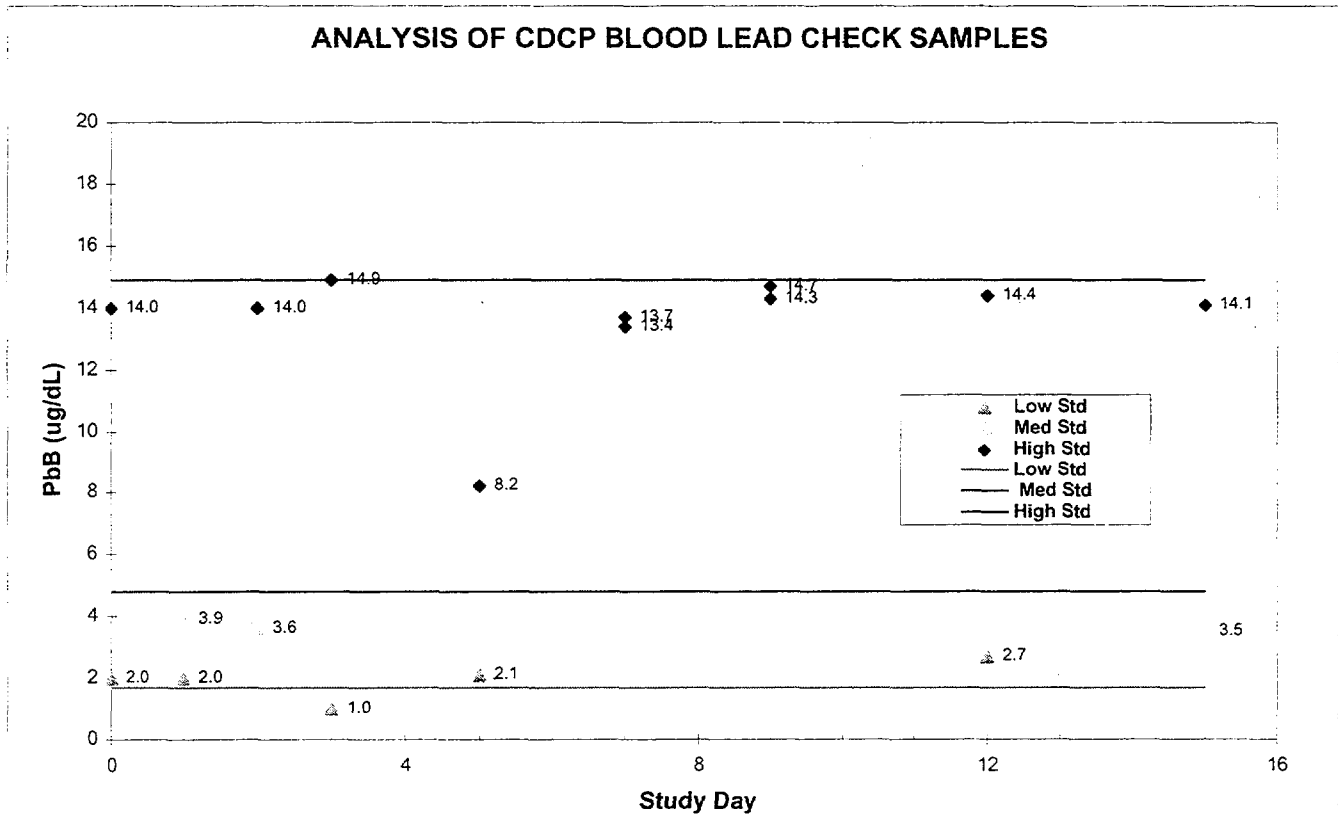
### Data Audits and Spreadsheet Validation

All analytical data generated by EPA's analytical laboratory were validated prior to being released in the form of a database file. These electronic data files were "decoded" (linking the sample tag to the correct animal and day) using Microsoft's database system ACCESS®. To ensure that no errors occurred in this process, original electronic files were printed out and compared to printouts of the tag assignments and the decoded data.

All spreadsheets used to manipulate the data and to perform calculations (see Appendix A) were validated by hand-checking random cells for accuracy.

FIGURE 3-2 CDCP CHECK SAMPLES

VBI70 LEAD



## 4.0 RESULTS

The following sections provide results based on the group means for each dose group investigated in this study. Appendix A provides detailed data for each individual animal. Results from this study will be compared and contrasted with the results from other studies in a subsequent report.

### 4.1 Blood Lead vs Time

Figure 4-1 shows the group mean blood lead values as a function of time during the study. As seen, blood lead values began at or below quantitation limits (about 1 ug/dL) in all groups, and remained at or below quantitation limits in control animals (Group 10). In animals given repeated oral doses of lead acetate (Groups 1-3), Eastern soil (Groups 4-6), or Western soil (Groups 7-9), blood levels began to rise within 1-2 days, and tended to plateau by the end of the study (day 15).

### 4.2 Dose-Response Patterns

#### Blood Lead

The measurement endpoint used to quantify the blood lead response was the area under the curve (AUC) for blood lead vs time (days 0-15). AUC was selected because it is the standard pharmacokinetic index of chemical uptake into the blood compartment, and is relatively insensitive to small variations in blood lead level by day. The AUC was calculated using the trapezoidal rule to estimate the AUC between each time point that a blood lead value was measured (days 0, 1, 2, 3, 5, 7, 9, 12, and 15), and summing the areas across all time intervals in the study. The detailed data and calculations are presented in Appendix A, and the results are shown graphically in Figure 4-2. Each data point reflects the group mean exposure and group mean response, with the variability in dose and response shown by standard error bars. The figure also shows the best-fit equation through each data set.

As seen, the dose response pattern is non-linear for both the soluble reference material (lead acetate, abbreviated "PbAc"), and for each of the two test soils. Dose response curves for both soils are similar to those seen for lead acetate.

#### Tissue Lead

The dose-response data for lead levels in bone, liver, and kidney (measured at sacrifice on day 15) are detailed in Appendix A, and are shown graphically in Figures 4-3 through 4-5, respectively. As seen, all of these dose response curves for tissues are fit by linear equations, both for lead acetate and each of the two test soils.

FIGURE 4-1 Group Mean PbB vs. Day  
VBI70 Lead

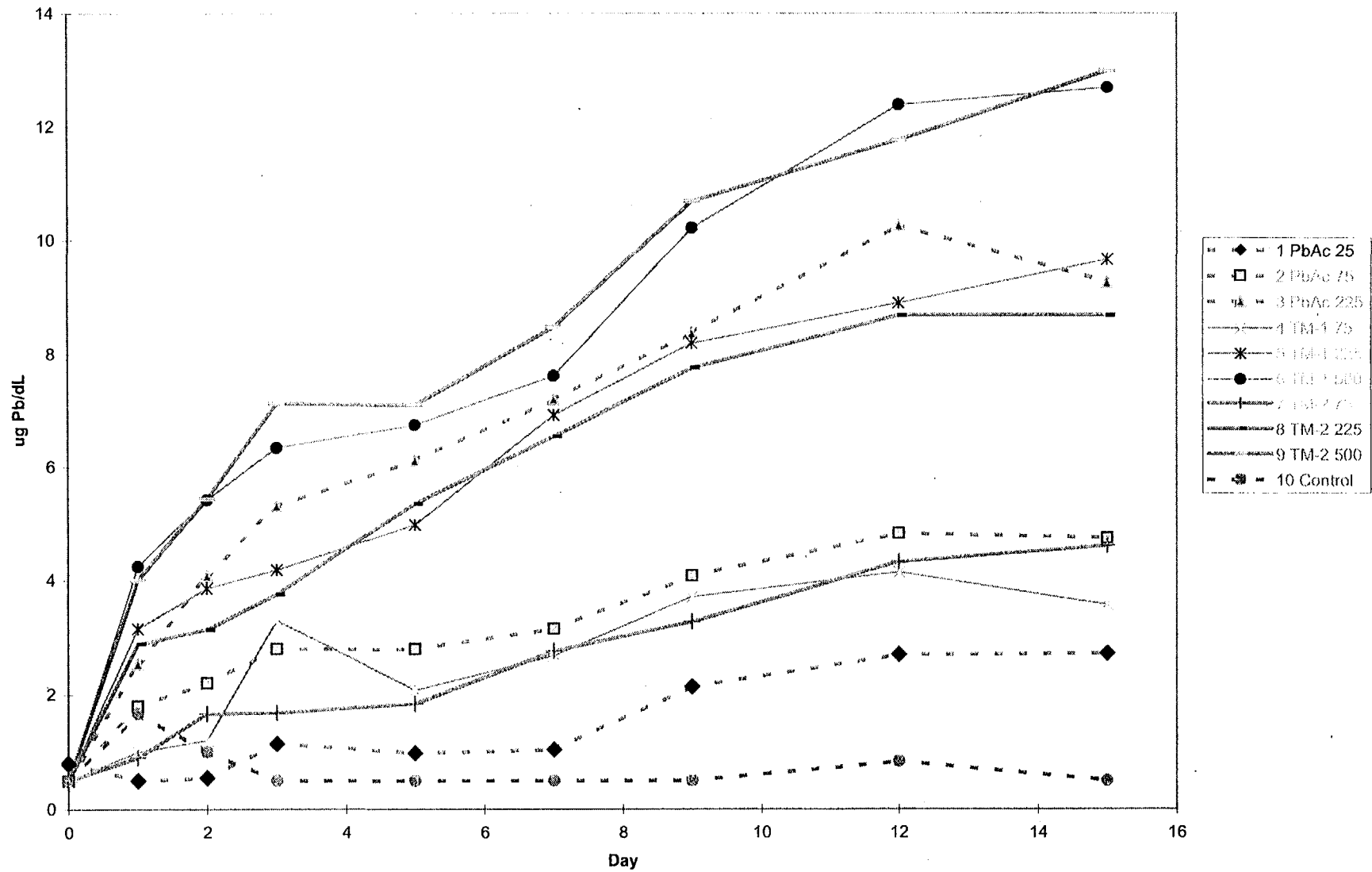


FIGURE 4-2 BLOOD LEAD AUC DOSE-RESPONSE,  
GROUP MEANS  $\pm$  SEM FOR VBI70 LEAD

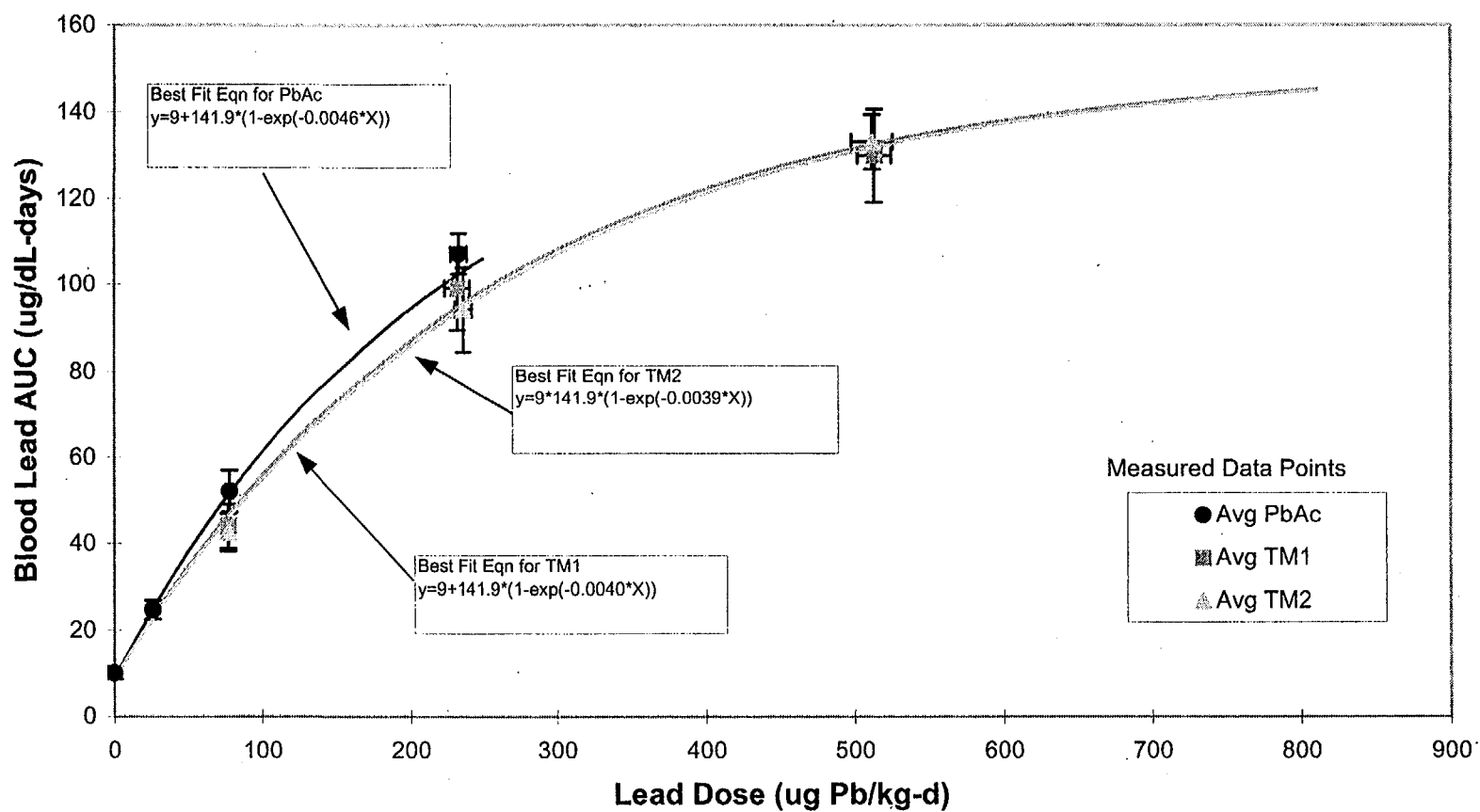


FIGURE 4-3 BONE LEAD DOSE-RESPONSE,  
GROUP MEANS + SEM FOR VBI70 LEAD

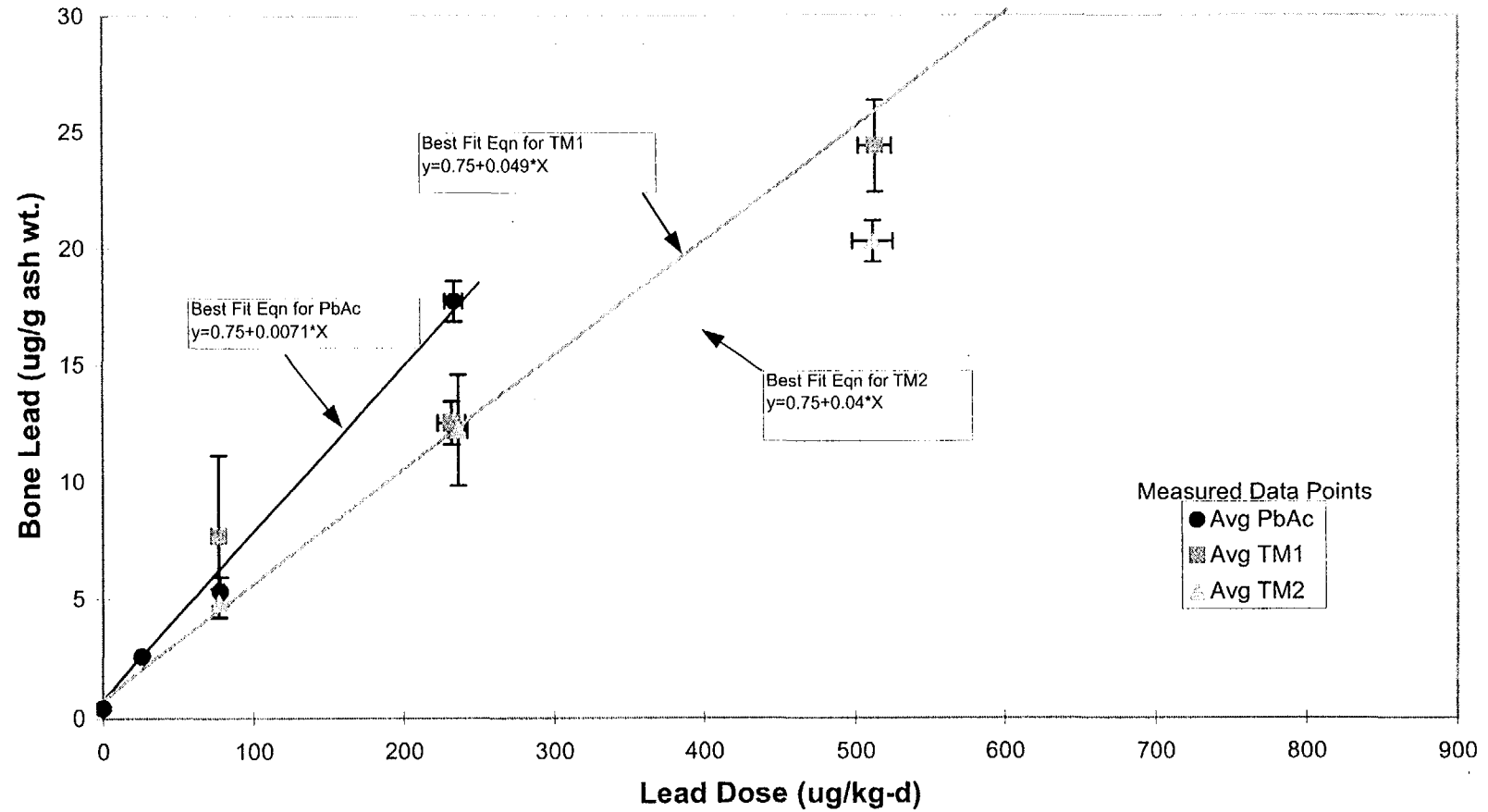


FIGURE 4-4 LIVER LEAD DOSE-RESPONSE,  
GROUP MEANS  $\pm$  SEM FOR VBI70 LEAD

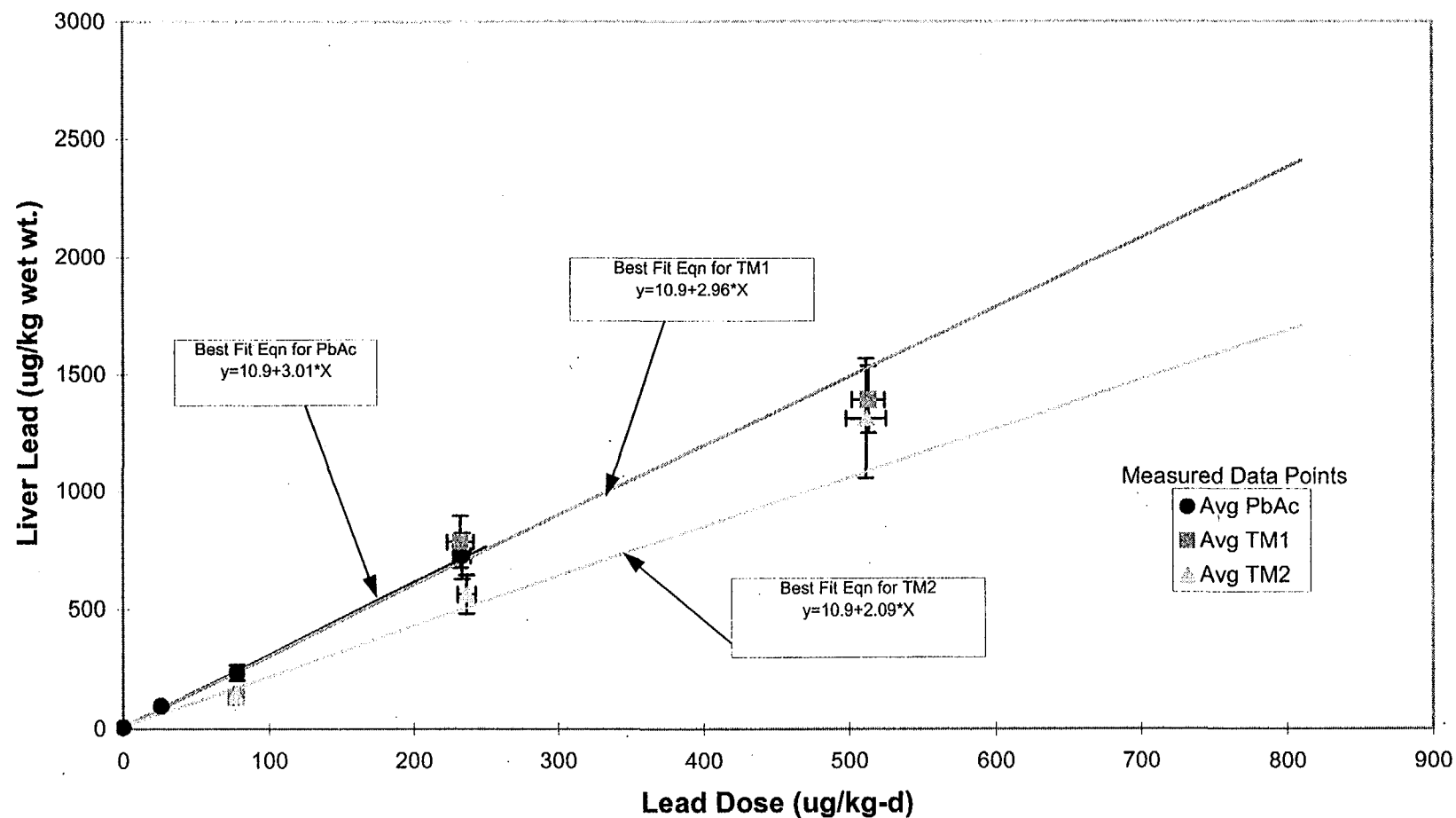
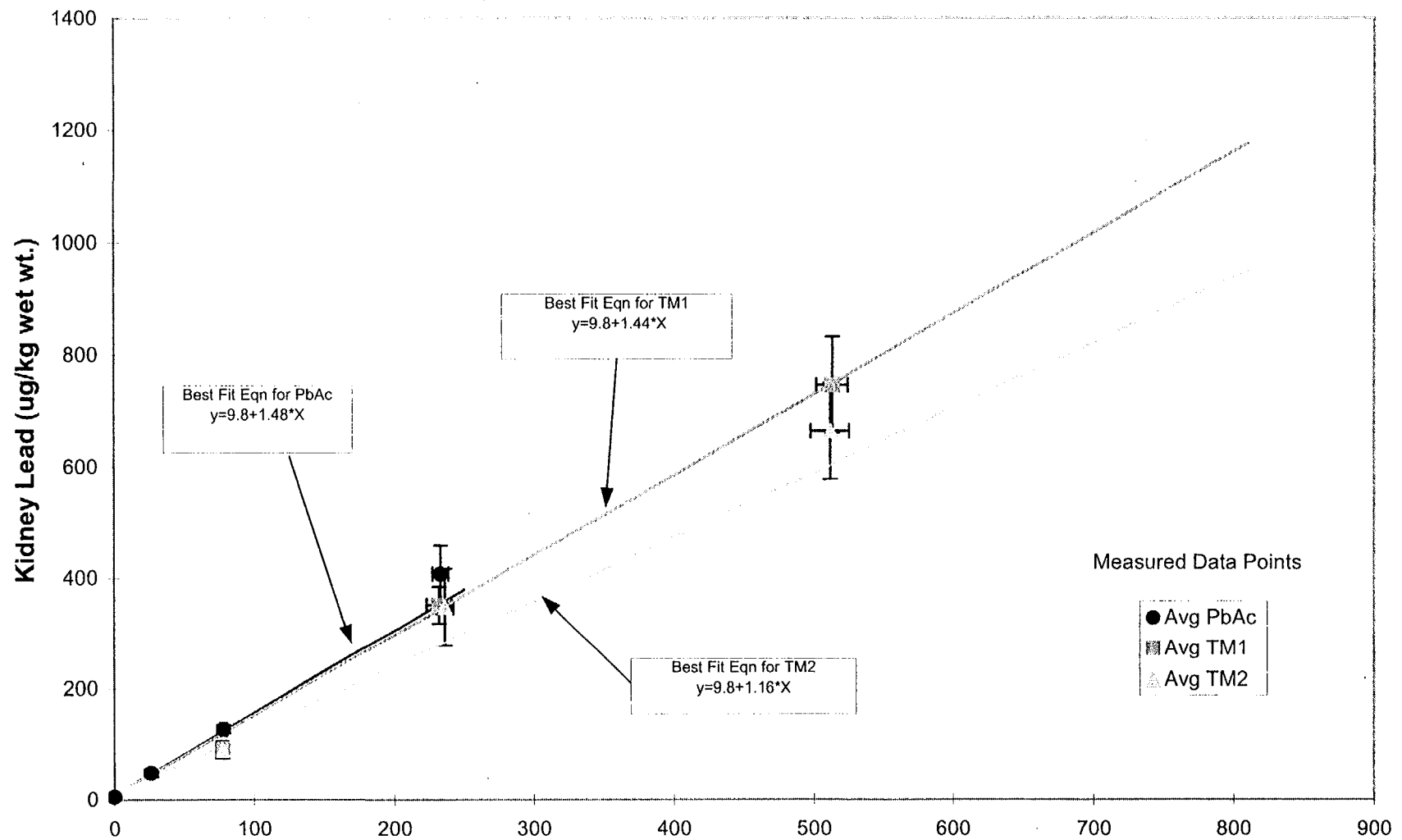


FIGURE 4-5 KIDNEY LEAD DOSE-RESPONSE,  
GROUP MEANS  $\pm$  SEM FOR VBI70 LEAD



### 4.3 Calculated RBA Values

Relative bioavailability values were calculated for each test material for each measurement endpoint (blood AUC, bone, liver, kidney) using the method described in Section 3.0. The results are shown below:

Measurement Endpoint	Estimated RBA	
	Eastern Test Material #1	Western Test Material #2
Blood Lead AUC	0.87	0.85
Liver Lead	0.98	0.70
Kidney Lead	0.97	0.78
Bone Lead	0.69	0.56

### Recommended RBA Values

For each test soil, the estimates of RBA based on blood, liver, kidney, and bone are generally similar, but do not agree exactly in all cases. In general, we recommend greatest emphasis be placed on the RBA estimates derived from the blood lead data. There are several reasons for this recommendation, including the following:

- 1) Blood lead calculations are based on multiple measurements over time, and so are statistically more robust than the single measurements available for tissue concentrations. Further, blood is a homogeneous medium, and is easier to sample than complex tissues such as liver, kidney and bone. Consequently, the AUC endpoint is less susceptible to random measurement errors, and RBA values calculated from AUC data are less uncertain.
2. Blood is the central compartment and one of the first compartments to be affected by absorbed lead. In contrast, uptake of lead into peripheral compartments (liver, kidney, bone) depend on transfer from blood to the tissue, and may be subject to a variety of toxicokinetic factors that could make bioavailability determinations more complicated.
3. The dose-response curve for blood lead is non-linear, similar to the non-linear dose-response curve observed in children (e.g., see Sherlock and Quinn 1986). Thus, the response of this endpoint is known to behave similarly in swine as in children, and it is not known if the same is true for the tissue endpoints.

4. Blood lead is the classical measurement endpoint for evaluating exposure and health effects in humans, and the health effects of lead are believed to be proportional to blood lead levels.

However, data from the tissue endpoints (liver, kidney, bone) also provide valuable information. We consider the plausible range to extend from the RBA based on blood AUC to the mean of the other three tissues (liver, kidney, bone). The preferred range is the interval from the RBA based on blood to the mean of the blood RBA and the tissue mean RBA. Our suggested point estimate is the mid-point of the preferred range. These values are presented below:

Relative Bioavailability of Lead	Test Material	
	Eastern Test Material #1	Western Test Material #2
Plausible Range	0.87-0.88	0.68-0.85
Preferred Range	0.87-0.88	0.76-0.85
Suggested Point Estimate	0.87	0.81

#### 4.4 Estimated Absolute Bioavailability in Children

These RBA estimates may be used to help assess lead risk at this site by refining the estimate of absolute bioavailability (ABA) of lead in soil, as follows:

$$ABA_{\text{soil}} = ABA_{\text{soluble}} * RBA_{\text{soil}}$$

Available data indicate that fully soluble forms of lead are about 50% absorbed by a child (USEPA 1991, 1994). Thus, the estimated absolute bioavailability of lead in the site samples is calculated as follows:

$$ABA_{\text{Site}} = 50\% * RBA_{\text{Site}}$$

Based on the RBA values shown above, the estimated absolute bioavailability in children is as follows:

Absolute Bioavailability of Lead	Test Material	
	Eastern Test Material #1	Western Test Material #2
Plausible Range	0.43-0.44	0.34-0.42
Preferred Range	0.43-0.44	0.38-0.42
Suggested Point Estimate	0.44	0.40

#### 4.5 Uncertainty

The bioavailability estimates above are subject to uncertainty that arises from several different sources. First, differences in physiological and pharmacokinetic parameters between individual animals leads to variability in response, even when exposure is the same. Because of this inter-animal variability in the responses of different animals to lead exposure, there is mathematical uncertainty in the best fit dose-response curves for both lead acetate and test material. This in turn leads to uncertainty in the calculated values of RBA, because these are derived from the two best-fit equations. Second, there is uncertainty in how to weight the RBA values based on the different endpoints, and how to select a point estimate for RBA that is applicable to typical site-specific exposure levels. Third, there is uncertainty in the quantitative extrapolation of measured RBA values in swine to young children. Even though the immature swine is believed to be a useful and meaningful animal model for gastrointestinal absorption in children, it is possible that differences in stomach pH, stomach emptying time, and other physiological parameters may exist and that RBA values in swine may not be precisely equal to values in children. Finally, studies in humans reveal that lead absorption is not constant even within an individual, but varies as a function of many factors (mineral intake, health status, etc.). One factor that may be of special importance is time after the last meal, with the presence of food tending to reduce lead absorption. The values of RBA measured in this study are intended to estimate the maximum uptake that occurs when lead is ingested in the absence of food. Thus, these values may be somewhat conservative for children who ingest lead along with food. The magnitude of this bias is not known, although preliminary studies in swine suggest the factor may be relatively minor.

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APPENDIX A

DETAILED DATA AND CALCULATIONS

## APPENDIX A

### DETAILED DATA SUMMARY

#### 1.0 OVERVIEW

Performance of this study involved collection and reduction of a large number of data items. All of these data items and all of the data reduction steps are contained in a Microsoft Excel spreadsheet named "VB\_LEAD.XLS". This file is intended to allow detailed review and evaluation of all aspects of this study.

The following sections of this Appendix present printouts of selected tables and graphs from the XLS file. These tables and graphs provide a more detailed documentation of the individual animal data and the data reduction steps performed in this study than was presented in the main text. Any additional details of interest to a reader can be found in the XLS spreadsheet.

#### 2.0 RAW DATA AND DATA REDUCTION STEPS

##### 2.1 Body Weights and Dose Calculations

Animals were weighed on day -1 (one day before exposure) and every three days thereafter during the course of the study. Doses of lead for the three days following each weighing were based on the group mean body weight, adjusted by addition of 1 kg to account for the expected weight gain over the interval. After completion of the experiment, body weights were estimated by interpolation for those days when measurements were not collected, and the actual administered doses ( $\mu\text{g Pb/kg}$ ) were calculated for each day and then averaged across all days. If an animal missed a dose or was given an incorrect dose, the calculation of average dose corrected for these factors. These data and data reduction steps are shown in Tables A-1 and A-2. During this study, one animal in Group 8, was inadvertently administered a Group 9 doughball in addition to its assigned doughball during the morning dosing on Day 3. This misdosing was accounted for in the spreadsheets for this experiment.

##### 2.2 Blood Lead vs Time

Blood lead values were measured in each animal on days 0, 1, 2, 3, 5, 7, 9, 12, and 15. The raw laboratory data (reported as  $\mu\text{g/L}$  of diluted blood) are shown in Table A-3. These data were adjusted as follows: a) non-detects were evaluated by assuming a value equal to one-half the quantitation limit, and b) the concentrations in diluted blood were converted to units of  $\mu\text{g/dL}$  in whole blood by dividing by a factor of 1 dL of blood per L of diluted sample. The results are shown in the right-hand column of Table A-3. Figures A-1

to A-3 plot the results for individual animals organized by group and by day. Figure A-4 plots the mean for each dosing group by day.

After adjustment as above, values that were more than a factor of 1.5 above or below the group mean for any given day were "flagged" by computer as potential outliers. These values are shown in Table A-4 by cells that are shaded gray. Each data point identified in this way was reviewed and professional judgment was used to decide if the value should be retained or excluded. In order to avoid inappropriate biases, blood lead outlier designations were restricted to values that were clearly aberrant from a time-course and/or dose-response perspective. Values which were excluded are identified by a heavy black box outlining the values. Rationale for outlier exclusion is provided in Table A-5.

### 2.3 Blood Lead AUC

The area under the blood lead vs time curve for each animal was calculated by finding the area under the curve for each time step using the trapezoidal rule:

$$AUC(d_i \text{ to } d_j) = 0.5 * (r_i + r_j) * (d_j - d_i)$$

where:

d = day number

r = response (blood lead value) on day i ( $r_i$ ) or day j ( $r_j$ )

The areas were then summed for each of the time intervals to yield the final AUC for each animal. These calculations are shown in Table A-6. If a blood lead value was missing (either because of problems with sample preparation, or because the measured value was excluded as an outlier), the blood lead value for that day was estimated by linear interpolation.

### 2.4 Liver, Kidney, and Bone Lead Data

At sacrifice (day 15), samples of liver, kidney, and bone (femur) were removed and analyzed for lead. The raw data (expressed as ug Pb/L of prepared sample) are summarized in Table A-7. These data were adjusted as follows: a) non-detects were evaluated by assuming a value equal to one-half the quantitation limit, and b) the concentrations in prepared sample were converted to units of concentration in the original biological sample by dividing by the following factors:

Liver:	0.1 kg wet weight/L prepared sample
Kidney:	0.1 kg wet weight/L prepared sample
Bone:	2 gm ashed weight/L prepared sample

The resulting values are shown in the right-hand column of Table A-7.

### 3.0 CURVE FITTING

#### Basic Equations

A commercial curve-fitting program (Table Curve-2D™ Version 2.0 for Windows, available from Jandel Scientific) was used to derive best fit equations for each of the individual dose-response data sets derived above. A least squares regression method was used for both linear and non-linear equations. As discussed in the text, three different user-defined equations were fit to each data set:

Linear (LIN):                      Response =  $a + b \cdot \text{Dose}$

Exponential (EXP):              Response =  $a + c \cdot (1 - \exp(-d \cdot \text{Dose}))$

Combination (LIN+EXP): Response =  $a + b \cdot \text{Dose} + c \cdot (1 - \exp(-d \cdot \text{Dose}))$

#### Constraints

In the process of finding the best-fits of these equations to the data, the values of the parameters (a, b, c, and d) were constrained as follows:

- Parameter "a" (the intercept, equal to the baseline or control value of the measurement endpoint) was constrained to be non-negative and was forced in all cases to be the same for the reference material (lead acetate) and the test materials. This is because, by definition, all dose-response curves for groups of animals exposed to different materials must arise from the same value at zero dose. In addition, for blood lead data, "a" was constrained to be equal to the mean of the control group  $\pm 20\%$  (typically  $7.5 \pm 1.5$  AUC units).
- Parameter "b" (the slope of the linear dose-response line) was constrained to non-negative values, since all of the measurement endpoints evaluated are observed to increase, not decrease, as a function of lead exposure.
- Parameter "c" (the plateau value of the exponential curve) was constrained to be non-negative, and was forced to be the same for the reference material (lead acetate) and the test material. This is because: 1) it is expected on theoretical grounds that the plateau (saturation level) should be the same regardless of the source of lead, and 2) curve-fitting of individual curves tended to yield values of "c" that were close to each other and were not statistically different.
- Parameter "d" (which determines where the "bend" in the exponential equation occurs) was constrained to be greater than 0.0045 for the lead

acetate blood lead (AUC) dose-response curve. This constraint was judged to be necessary because the weight of evidence from all studies clearly showed the lead acetate blood lead dose response curve was non-linear and was best fit by an exponential equation, but in some studies there were only two low doses of lead acetate used to define the dose-response curve, and this narrow range data set could sometimes be fit nearly as well by a linear as an exponential curve. The choice of the constraint on "d" was selected to be slightly lower than the observed best-fit value of "d" (0.006) when data from all lead acetate AUC dose-response curves from all of the different studies in this program were used. This approach may tend to underestimate relative bioavailability slightly in some studies (especially at low dose), but use of the information gained from all studies is judged to be more robust than basing fits solely on the data from one study.

In general, one of these models (the linear, the exponential, or the combination) usually yielded a fit (as judged by the value of the adjusted correlation coefficient  $R^2$  and by visual inspection of the fit of the line through the measured data points) that was clearly superior to the others. If two or more models fit the data approximately equally well, then the simplest model (that with the fewest parameters) was selected.

#### Outlier Identification

During the dose-response curve fitting process, all data were carefully reviewed to identify any anomalous values. Typically, the process used to identify outliers was as follows:

- |        |   |
|--------|---|
| Step 1 | Any data points judged to be outliers based on information derived from analysis of data across multiple studies (as opposed to conclusions drawn from within the study) were excluded ( <i>a priori</i> outliers).   |
| Step 2 | The remaining raw data points were fit to the equation judged to be the most likely to be the best fit (linear, exponential, or mixed). Table Curve 2-D was then used to plot the 95% prediction limits around the best fit line. All data points that fell outside the 95% prediction limits were considered to be outliers and were excluded. |
| Step 3 | After excluding these points (if any), a new best-fit was obtained. In some cases, data points originally inside the 95% prediction limits were now outside the limits. However, further iterative cycles of data point exclusion were not performed, and the fit was considered final.   |

It should be noted that professional judgment can be imposed during any stage of the above outlier identification process. Table A-8 shows outliers selected using professional judgement.

## Curve Fit Results

Table A-8 lists the data used to fit these curves, indicating which endpoints were excluded as outliers and why. Table A-9 shows the type of equation selected to fit each data set, and the best fit parameters. The resulting best-fit equations for the data sets are shown in Figures A-4 to A-15. Values excluded as outliers are represented in the figures by the symbol "+".

## **4.0 RESULTS -- CALCULATED RBA VALUES**

The value of RBA for a test substance was calculated for a series of doses using the following procedure:

1. For each dose, calculate the expected response to test material, using the best fit equation through the dose-response data for that material.
2. For each expected response to test material, calculate the dose of lead acetate that is expected to yield an equivalent response. This is done by "inverting" the dose-response curve for lead acetate, solving for the dose that corresponds to a specified response.
3. Calculate RBA at that dose as the ratio of the dose of lead acetate to the dose of test material. For the situation where both curves are linear, the value of RBA is the ratio of the slopes (the "b" parameters). In the case where both curves are exponential and where both curves have the same values for parameters "a" and "c", the value of RBA is equal to the ratio of the "d" parameters.

The results are summarized in Table A-10.

## **5.0 QUALITY ASSURANCE DATA**

A number of steps were taken throughout this study and the other studies in this project to ensure the quality of the results, including 5% duplicates, 5% standards, a program of interlaboratory comparison. These steps are detailed below.

### Duplicates

Duplicate samples were prepared and analyzed for about 5% of all samples generated during the study. Table A-11 lists the first and second values for blood, liver, kidney, and bone. The results are shown in Figure 3-1 in the main text.

## Standards

The Centers for Disease Control and Prevention (CDCP) provides a variety of blood lead "check samples" for use in quality assurance programs for blood lead studies. Each time a group of blood samples was prepared and sent to the laboratory for analysis, several CDCP check samples of different concentrations were included. Table A-12 lists the concentrations reported by the laboratory compared to the nominal concentrations indicated by CDCP for the samples submitted during this study, and the results are plotted in Figure 3-2 in the main text.

TABLE A-1 BODY WEIGHTS AND ADMINISTERED DOSES, BY DAY

Body weights were measured on days -1, 2, 5, 8, 11, 14. Weights for other days are estimated, based on linear interpolation between measured values.

Group	ID #	Day -1	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Day 15
		BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)	BW (kg)
		ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day	ug Pb per day
1	311	9.5	10.0	10.5	11.06	11.4	11.7	11.95	12.0	12.1	12.23	12.8	13.4	13.98	13.9	13.9	13.88	13.8
1	326	9.04	9.6	10.1	10.66	10.9	11.1	11.36	11.5	11.7	11.85	12.4	13.0	13.62	13.7	13.7	13.8	13.9
1	338	9.76	10.1	10.4	10.75	11.4	12.1	12.84	13.1	13.3	13.53	13.9	14.3	14.66	14.7	14.8	14.85	14.9
1	343	8.34	8.6	8.8	9.07	9.2	9.4	9.5	9.8	10.1	10.35	10.8	11.3	11.77	12.0	12.2	12.35	12.5
1	349	9.17	9.6	10.1	10.54	10.7	10.8	10.96	11.3	11.7	12.1	12.6	13.0	13.4	13.6	13.8	13.96	14.1
2	304	9.88	10.4	10.9	11.33	11.6	11.9	12.12	12.6	13.0	13.5	13.8	14.0	14.29	14.5	14.8	15.04	15.3
2	307	9.47	9.6	9.8	9.9	10.0	10.1	10.26	10.8	11.3	11.81	12.2	12.6	13.05	13.1	13.2	13.3	13.4
2	312	9.04	9.3	9.6	9.82	9.9	10.1	10.18	10.5	10.8	11.08	11.4	11.7	12.04	12.3	12.6	12.96	13.3
2	314	9.57	9.7	9.9	10.08	10.4	10.8	11.16	11.5	11.9	12.2	12.4	12.6	12.85	13.2	13.6	13.9	14.3
2	350	9.75	10.0	10.3	10.58	11.0	11.4	11.85	12.2	12.5	12.78	13.2	13.6	14.02	14.2	14.4	14.61	14.8
3	302	8.77	9.0	9.3	9.53	9.8	10.1	10.4	10.8	11.2	11.64	12.1	12.5	12.92	13.1	13.3	13.5	13.7
3	303	10.85	11.1	11.4	11.64	11.7	11.8	11.95	12.1	12.2	12.3	12.6	13.0	13.41	13.6	13.8	14.08	14.3
3	322	9.2	9.5	9.9	10.19	10.7	11.2	11.72	12.0	12.3	12.53	13.0	13.5	13.95	14.1	14.3	14.45	14.6
3	327	9.32	9.3	9.3	9.28	9.6	9.9	10.23	10.8	11.3	11.79	12.2	12.6	12.95	13.2	13.5	13.81	14.1
3	342	9.14	9.5	9.8	10.12	10.3	10.4	10.61	11.1	11.6	12.11	12.6	13.0	13.44	13.8	14.2	14.64	15.0
4	313	9.55	10.1	10.6	11.19	11.4	11.8	12.33	12.6	12.9	13.3	13.6	13.9	14.3	14.6	14.9	15.2	15.5
4	328	8.6	9.0	9.5	9.89	10.4	10.9	11.35	11.6	11.9	12.3	12.6	13.0	13.4	13.8	14.1	14.4	14.7
4	329	8.8	9.0	9.3	9.54	9.8	10.2	10.57	11.0	11.5	11.9	12.4	12.9	13.46	13.9	14.4	14.9	15.4
4	333	9.6	9.8	10.0	10.27	10.6	11.0	11.3	11.6	11.9	12.3	12.6	13.0	13.4	13.8	14.1	14.4	14.7
4	348	10.28	10.6	11.0	11.34	11.5	11.8	12.1	12.4	12.7	13.0	13.3	13.6	13.9	14.2	14.5	14.8	15.1
5	317	8.42	8.8	9.3	9.69	9.7	10.3	10.82	11.6	12.0	12.52	12.9	13.3	13.66	14.2	14.7	15.22	15.7
5	324	8.23	8.8	9.3	9.83	10.0	10.6	11.09	11.4	11.8	12.27	12.6	13.0	13.33	13.7	14.1	14.44	14.8
5	340	9.5	9.6	9.7	9.88	10.5	11.1	11.77	12.0	12.3	12.52	12.9	13.3	13.67	14.1	14.5	14.97	15.4
5	341	9.1	9.3	9.4	9.58	9.9	10.2	10.53	11.3	11.7	12.0	12.3	12.6	12.9	13.1	13.3	13.5	13.8
5	354	11.25	11.5	11.7	11.88	12.4	12.8	13.29	13.6	13.9	14.13	14.6	15.0	15.31	15.6	15.9	16.2	16.5
6	321	8.5	8.8	9.1	9.35	9.8	10.2	10.61	11.2	11.6	12.05	12.5	12.9	13.31	13.7	14.1	14.41	14.8
6	332	10.1	10.1	10.1	10.11	10.3	10.4	10.4	11.2	11.8	12.4	13.0	13.6	14.11	14.6	15.1	15.6	16.1
6	335	10.03	10.1	10.3	10.38	10.9	11.4	11.86	12.3	12.7	13.05	13.7	14.4	15.02	15.4	15.7	16.06	16.4
6	355	7.81	8.3	8.9	9.42	9.7	10.1	10.38	10.9	11.3	11.81	12.5	13.1	13.73	14.3	14.9	15.5	16.1
6	363	8.8	9.1	9.5	9.83	10.4	10.9	11.5	11.8	12.0	12.25	12.7	13.1	13.54	13.9	14.2	14.56	14.9
7	305	9.15	9.3	9.4	9.46	9.9	10.3	10.66	11.1	11.5	11.97	12.4	12.9	13.32	13.6	13.9	14.21	14.5
7	306	9.55	10.0	10.4	10.85	11.1	11.4	11.84	12.3	12.6	12.97	13.0	13.4	13.74	14.1	14.5	14.88	15.3
7	318	9.4	9.6	9.9	10.08	10.3	10.4	10.6	11.1	11.5	11.88	12.3	12.7	13.0	13.4	13.7	14.06	14.4
7	320	8.67	9.1	9.5	9.93	10.3	10.7	11.14	11.5	11.9	12.31	12.7	13.0	13.35	13.8	14.2	14.59	14.9
7	347	9.7	10.0	10.4	10.71	11.0	11.4	11.68	12.0	12.4	12.71	13.0	13.3	13.6	14.0	14.3	14.67	15.0
8	301	10.17	10.3	10.4	10.53	10.7	10.9	11.11	11.4	11.8	12.11	12.4	12.7	13.03	13.3	13.6	13.9	14.2
8	318	10.12	10.2	10.3	10.37	10.9	11.4	11.85	12.3	12.8	13.24	13.7	14.1	14.5	14.9	15.3	15.7	16.1
8	352	10.06	10.2	10.4	10.55	11.1	11.6	12.08	12.6	13.1	13.58	14.0	14.5	15.02	15.4	15.7	16.06	16.4
8	358	9.35	9.7	10.0	10.32	10.7	11.0	11.39	11.8	12.3	12.71	13.1	13.5	13.9	14.3	14.7	15.1	15.5
8	359	8.75	9.1	9.5	9.84	10.4	10.9	11.22	11.6	12.0	12.21	12.6	13.0	13.31	13.7	14.0	14.31	14.6
9	309	11.25	11.5	11.8	12.12	12.5	12.8	13.17	13.5	13.8	14.1	14.5	14.8	15.1	15.4	15.7	16.0	16.3
9	330	9.65	10.0	10.4	10.7	11.3	11.8	12.35	12.7	13.0	13.38	13.7	14.0	14.3	14.6	14.9	15.2	15.5
9	351	11.6	11.8	12.0	12.12	12.5	12.8	13.17	13.5	13.8	14.1	14.5	14.8	15.1	15.4	15.7	16.0	16.3
9	353	9.04	9.5	9.9	10.27	10.6	11.0	11.39	11.8	12.3	12.71	13.1	13.5	13.9	14.3	14.7	15.1	15.5
9	358	10.6	10.9	11.2	11.48	12.0	12.5	12.96	13.4	13.8	14.18	14.7	15.2	15.7	16.2	16.7	17.2	17.7
10	325	9.09	9.5	10.0	10.45	10.9	11.4	11.85	12.3	12.7	13.0	13.3	13.6	13.9	14.2	14.5	14.8	15.1
10	337	9.16	9.6	10.1	10.56	11.0	11.5	11.95	12.4	12.8	13.1	13.4	13.7	14.0	14.3	14.6	14.9	15.2
10	360	9.7	9.8	9.9	10.03	10.3	10.6	10.86	11.1	11.4	11.6	11.9	12.2	12.5	12.8	13.1	13.4	13.7

On 11/2/2000 (AM Dose), Pig #358 (group 8) received 100% of the Group 8 dose and 95% of the Group 9 dose

**TABLE A-2**  
**Body Weight Adjusted Doses**  
(Dose for Day/BW for Day)

Group	ID #	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Avg Dose	Target Dose	% Target	Avg %
1	311	25.35	24.10	22.97	25.13	24.49	23.88	25.58	25.38	25.19	25.39	24.28	23.27	25.97	26.03	26.09	24.87	25	99	
1	326	26.52	25.10	23.83	26.20	25.65	25.12	26.73	26.36	26.00	26.15	24.97	23.88	26.47	26.36	26.24	25.71	25	103	
1	338	25.18	24.38	23.63	24.93	23.50	22.23	23.57	23.18	22.77	23.39	22.77	22.19	24.60	24.49	24.39	23.68	25	95	
1	343	29.60	28.78	28.01	30.98	30.50	30.04	31.49	30.60	29.76	30.06	28.80	27.64	30.27	29.79	29.32	29.71	25	119	
1	349	26.39	25.20	24.10	26.72	26.38	26.04	27.16	26.28	25.46	25.95	25.09	24.28	26.65	26.29	25.94	25.86	25	103	104
2	304	76.26	72.88	69.80	73.37	71.74	70.19	72.22	69.67	67.30	72.31	70.95	69.65	73.50	72.26	71.06	71.55	75	95	
2	307	82.28	81.05	79.88	84.90	83.89	82.91	84.31	80.45	76.93	81.42	78.76	76.26	81.38	80.86	80.36	81.04	75	108	
2	312	85.03	82.72	80.53	85.58	84.56	83.56	86.75	84.39	82.15	87.40	84.97	82.66	86.56	84.46	82.47	84.25	75	112	
2	314	81.19	79.80	78.45	81.48	78.76	76.22	78.96	76.65	74.47	80.15	78.78	77.45	80.97	78.87	76.89	78.61	75	105	
2	350	78.87	76.75	74.74	77.31	74.44	71.78	74.72	72.86	71.09	75.44	73.14	70.99	75.18	74.15	73.15	74.31	75	99	104
3	302	260.72	253.60	246.86	255.52	248.19	241.27	248.19	239.06	230.57	246.69	238.27	230.40	250.06	246.43	242.90	245.25	225	109	
3	303	211.69	206.79	202.11	215.32	215.07	214.83	220.95	212.77	205.18	219.04	211.12	203.75	225.63	226.83	228.04	214.61	225	95	
3	322	246.86	238.60	230.87	234.50	223.84	214.10	223.84	218.91	214.19	228.92	220.88	213.39	232.29	229.58	226.93	226.51	225	101	
3	327	252.79	253.15	253.51	261.47	253.11	245.28	249.66	238.14	227.63	244.46	236.94	229.86	247.73	242.48	237.45	244.91	225	109	
3	342	248.51	240.22	232.47	244.01	240.19	236.49	241.57	231.18	221.62	237.13	229.04	221.48	236.93	230.28	223.99	234.34	225	104	104
4	313	75.49	71.61	68.11	74.18	73.03	71.91	77.16	75.95	74.78	77.06	73.75	70.72	76.57	75.39	74.24	74.00	75	99	
4	328	84.40	80.57	77.06	81.28	77.64	74.31	79.11	77.27	75.52	78.83	76.37	74.05	80.59	79.74	78.92	78.38	75	105	
4	329	84.25	82.01	79.89	85.34	82.48	79.80	83.52	80.29	77.29	79.85	76.60	73.61	79.53	78.14	76.81	79.96	75	107	
4	333	86.38	84.25	82.22	86.51	82.45	78.75	83.49	81.23	79.09	82.69	80.21	77.88	83.40	81.25	79.20	81.93	75	109	
4	348	71.77	69.41	67.21	73.05	71.76	70.52	74.46	72.16	70.00	73.70	71.97	70.32	75.36	73.46	71.66	71.79	75	96	103
5	317	268.13	261.37	254.95	256.18	241.02	227.55	243.48	232.65	222.74	240.56	233.67	227.17	232.78	224.54	216.87	238.91	225	106	
5	324	264.45	249.28	235.76	247.50	242.43	237.56	254.98	244.33	234.54	254.85	248.99	243.39	256.93	255.02	253.13	248.21	225	110	
5	340	240.90	237.94	235.04	236.73	223.19	211.12	232.00	227.27	222.74	240.50	233.56	227.01	234.04	227.06	220.49	229.97	225	102	
5	341	250.45	246.37	242.42	251.42	243.46	235.98	246.35	230.28	216.17	244.99	249.59	254.36	261.27	252.61	244.50	244.68	225	109	
5	354	202.23	198.59	195.08	201.21	193.83	186.98	205.50	201.35	197.36	210.01	201.20	193.11	200.82	196.43	192.24	198.39	225	88	103
6	321	571.99	554.12	537.33	553.63	530.81	509.80	537.92	512.52	489.41	533.53	523.22	513.30	561.44	551.32	541.56	534.79	500	107	
6	332	497.26	497.10	496.93	526.51	518.27	510.28	536.16	508.90	484.27	514.88	493.21	473.28	521.20	515.19	509.31	506.85	500	101	
6	335	495.14	489.51	484.01	495.94	473.09	452.26	487.29	473.33	460.15	487.21	464.93	444.81	484.23	473.55	463.33	475.24	500	95	
6	355	601.92	565.55	533.33	555.34	537.67	521.10	553.12	529.85	508.47	536.39	510.16	486.38	539.33	536.74	534.17	536.63	500	107	
6	363	549.47	529.59	511.09	520.76	494.27	470.35	511.06	500.42	490.20	526.66	509.38	493.21	536.10	523.28	511.06	511.79	500	102	103
7	305	83.43	82.51	81.61	85.24	81.92	78.84	81.94	78.84	75.98	80.48	77.67	75.05	80.26	78.55	76.91	79.95	75	107	
7	306	77.33	74.12	71.16	75.85	74.31	72.83	76.30	73.97	71.77	76.73	74.69	72.75	77.40	75.37	73.45	74.54	75	99	
7	316	80.20	78.35	76.59	81.97	80.61	79.29	82.22	78.93	75.90	81.14	78.96	76.89	81.84	79.73	77.73	79.36	75	106	
7	320	84.93	81.18	77.75	81.33	78.28	75.44	78.86	76.28	73.87	78.48	75.94	73.55	79.23	78.08	76.96	78.01	75	104	
7	347	76.92	74.43	72.09	76.17	74.00	71.96	75.63	73.53	71.54	75.67	72.91	70.34	75.39	73.93	72.52	73.80	75	98	103
8	301	233.75	231.05	228.42	237.98	233.77	229.70	246.33	239.35	232.77	250.57	244.53	238.78	244.40	240.35	236.43	237.88	225	106	
8	318	235.73	233.82	231.94	234.91	224.71	215.35	235.95	234.05	232.19	245.11	234.87	225.46	229.18	223.90	218.86	230.40	225	102	
8	352	235.27	231.57	227.99	230.74	220.57	211.25	211.41	193.24	177.95	209.84	225.24	243.07	238.70	225.88	214.37	219.81	225	98	
8	356	248.65	240.61	233.07	239.10	231.43	224.25	244.40	241.20	238.07	250.57	239.45	229.28	233.31	228.16	223.23	236.32	225	105	
8	358	262.96	252.03	241.98	525.99	236.44	227.45	244.05	237.27	230.86	244.34	234.70	225.78	232.97	230.92	228.91	257.11	225	114	105
9	309	495.15	483.01	471.45	489.21	475.38	462.30	500.20	489.45	479.15	504.39	490.96	478.22	502.54	484.73	468.13	484.95	500	97	
9	330	571.40	552.08	534.02	542.84	517.54	494.49	532.25	518.23	504.93	522.53	500.59	480.42	510.69	497.94	485.81	517.72	500	104	
9	351	493.72	494.86	496.01	511.90	494.89	478.98	515.20	501.31	488.15	514.08	500.59	487.79	519.34	507.12	495.47	499.96	500	100	
9	353	604.66	579.51	556.38	575.59	557.72	540.92	575.80	554.83	535.34	566.38	553.94	542.03	576.23	561.89	548.25	561.96	500	112	
9	359	524.86	511.40	498.60	510.62	490.13	471.22	505.44	490.51	476.45	496.96	479.58	463.37	498.87	492.41	486.11	493.10	500	99	102
10	325	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0		
10	337	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0		
10	360	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0		

TABLE A - 3 RAW AND ADJUSTED BLOOD LEAD DATA

pig number	sample	group	material administered	dosage	qualifier	result	day	MATRIX	Adjusted Value ( ) <sup>a</sup>	Notes
311	VB-03-0173	1	PbAc	25	<	1.0	0	Blood	0.5	
326	VB-03-0221	1	PbAc	25		2.0	0	Blood	2.0	
338	VB-03-0214	1	PbAc	25	<	1.0	0	Blood	0.5	
343	VB-03-0212	1	PbAc	25	<	1.0	0	Blood	0.5	
349	VB-03-0205	1	PbAc	25	<	1.0	0	Blood	0.5	
304	VB-03-0217	2	PbAc	75	<	1.0	0	Blood	0.5	
307	VB-03-0223	2	PbAc	75	<	1.0	0	Blood	0.5	
312	VB-03-0194	2	PbAc	75	<	1.0	0	Blood	0.5	
314	VB-03-0188	2	PbAc	75	<	1.0	0	Blood	0.5	
350	VB-03-0196	2	PbAc	75	<	1.0	0	Blood	0.5	
302	VB-03-0186	3	PbAc	225	<	1.0	0	Blood	0.5	
303	VB-03-0203	3	PbAc	225	<	1.0	0	Blood	0.5	
322	VB-03-0219	3	PbAc	225	<	1.0	0	Blood	0.5	
327	VB-03-0198	3	PbAc	225	<	1.0	0	Blood	0.5	
342	VB-03-0197	3	PbAc	225	<	1.0	0	Blood	0.5	
313	VB-03-0180	4	Site 1	75	<	1.0	0	Blood	0.5	
328	VB-03-0183	4	Site 1	75	<	1.0	0	Blood	0.5	
329	VB-03-0213	4	Site 1	75	<	1.0	0	Blood	0.5	
333	VB-03-0195	4	Site 1	75	<	1.0	0	Blood	0.5	
348	VB-03-0199	4	Site 1	75	<	1.0	0	Blood	0.5	
317	VB-03-0175	5	Site 1	225	<	1.0	0	Blood	0.5	
324	VB-03-0182	5	Site 1	225	<	1.0	0	Blood	0.5	
340	VB-03-0176	5	Site 1	225	<	1.0	0	Blood	0.5	
341	VB-03-0200	5	Site 1	225	<	1.0	0	Blood	0.5	
354	VB-03-0206	5	Site 1	225	<	1.0	0	Blood	0.5	
321	VB-03-0174	6	Site 1	500	<	1.0	0	Blood	0.5	
332	VB-03-0216	6	Site 1	500		8.1	0	Blood	8.1	
335	VB-03-0207	6	Site 1	500	<	1.0	0	Blood	0.5	
355	VB-03-0187	6	Site 1	500	<	1.0	0	Blood	0.5	
363	VB-03-0208	6	Site 1	500	<	1.0	0	Blood	0.5	
305	VB-03-0201	7	Site 2	75	<	1.0	0	Blood	0.5	
306	VB-03-0220	7	Site 2	75	<	1.0	0	Blood	0.5	
316	VB-03-0210	7	Site 2	75	<	1.0	0	Blood	0.5	
320	VB-03-0209	7	Site 2	75	<	1.0	0	Blood	0.5	
347	VB-03-0218	7	Site 2	75	<	1.0	0	Blood	0.5	
301	VB-03-0190	8	Site 2	225	<	1.0	0	Blood	0.5	
318	VB-03-0189	8	Site 2	225	<	1.0	0	Blood	0.5	
352	VB-03-0224	8	Site 2	225	<	1.0	0	Blood	0.5	
356	VB-03-0204	8	Site 2	225	<	1.0	0	Blood	0.5	
358	VB-03-0193	8	Site 2	225	<	1.0	0	Blood	0.5	
309	VB-03-0185	9	Site 2	500	<	1.0	0	Blood	0.5	
330	VB-03-0181	9	Site 2	500	<	1.0	0	Blood	0.5	
351	VB-03-0179	9	Site 2	500	<	1.0	0	Blood	0.5	
353	VB-03-0215	9	Site 2	500	<	1.0	0	Blood	0.5	
359	VB-03-0177	9	Site 2	500	<	1.0	0	Blood	0.5	
325	VB-03-0184	10	Control	0	<	1.0	0	Blood	0.5	
337	VB-03-0225	10	Control	0	<	1.0	0	Blood	0.5	
360	VB-03-0192	10	Control	0	<	1.0	0	Blood	0.5	
311	VB-03-0244	1	PbAc	25	<	1.0	1	Blood	0.5	
326	VB-03-0228	1	PbAc	25	<	1.0	1	Blood	0.5	
338	VB-03-0237	1	PbAc	25	<	1.0	1	Blood	0.5	
343	VB-03-0257	1	PbAc	25	<	1.0	1	Blood	0.5	
349	VB-03-0269	1	PbAc	25	<	1.0	1	Blood	0.5	
304	VB-03-0277	2	PbAc	75		2.0	1	Blood	2.0	
307	VB-03-0247	2	PbAc	75		2.0	1	Blood	2.0	
312	VB-03-0253	2	PbAc	75		1.0	1	Blood	1.0	
314	VB-03-0272	2	PbAc	75		2.0	1	Blood	2.0	
350	VB-03-0240	2	PbAc	75		2.0	1	Blood	2.0	
302	VB-03-0230	3	PbAc	225		2.0	1	Blood	2.0	
303	VB-03-0260	3	PbAc	225		2.0	1	Blood	2.0	
322	VB-03-0258	3	PbAc	225		4.7	1	Blood	4.7	
327	VB-03-0243	3	PbAc	225		3.0	1	Blood	3.0	
342	VB-03-0266	3	PbAc	225		1.0	1	Blood	1.0	
313	VB-03-0262	4	Site 1	75	<	1.0	1	Blood	0.5	
328	VB-03-0242	4	Site 1	75		1.0	1	Blood	1.0	
329	VB-03-0278	4	Site 1	75	<	1.0	1	Blood	0.5	
333	VB-03-0229	4	Site 1	75		2.0	1	Blood	2.0	
348	VB-03-0254	4	Site 1	75		1.0	1	Blood	1.0	
317	VB-03-0232	5	Site 1	225		3.0	1	Blood	3.0	
324	VB-03-0239	5	Site 1	225		3.6	1	Blood	3.6	
340	VB-03-0263	5	Site 1	225		2.0	1	Blood	2.0	
341	VB-03-0234	5	Site 1	225		5.2	1	Blood	5.2	
354	VB-03-0274	5	Site 1	225		2.0	1	Blood	2.0	
321	VB-03-0265	6	Site 1	500		4.0	1	Blood	4.0	
332	VB-03-0236	6	Site 1	500		3.1	1	Blood	3.1	
335	VB-03-0235	6	Site 1	500		3.2	1	Blood	3.2	
355	VB-03-0256	6	Site 1	500		6.9	1	Blood	6.9	
363	VB-03-0264	6	Site 1	500		4.0	1	Blood	4.0	
305	VB-03-0255	7	Site 2	75	<	1.0	1	Blood	0.5	
306	VB-03-0273	7	Site 2	75		1.0	1	Blood	1.0	
316	VB-03-0259	7	Site 2	75		1.0	1	Blood	1.0	
320	VB-03-0261	7	Site 2	75		1.0	1	Blood	1.0	
347	VB-03-0249	7	Site 2	75		1.0	1	Blood	1.0	
301	VB-03-0268	8	Site 2	225		3.0	1	Blood	3.0	
318	VB-03-0241	8	Site 2	225		2.0	1	Blood	2.0	
352	VB-03-0227	8	Site 2	225		3.9	1	Blood	3.9	
356	VB-03-0245	8	Site 2	225		2.0	1	Blood	2.0	
358	VB-03-0251	8	Site 2	225		3.5	1	Blood	3.5	
309	VB-03-0276	9	Site 2	500		4.5	1	Blood	4.5	
330	VB-03-0250	9	Site 2	500		5.7	1	Blood	5.7	
351	VB-03-0233	9	Site 2	500		2.0	1	Blood	2.0	

pig number	sample	group	material administered	dosage	qualifier	result	day	MATRIX	Adjusted Value ( ) <sup>a</sup>	Notes
353	VB-03-0246	9	Site 2	500		4.1	1	Blood	4.1	
359	VB-03-0271	9	Site 2	500		3.7	1	Blood	3.7	
325	VB-03-0252	10	Control	0	<	1.0	1	Blood	0.5	
337	VB-03-0248	10	Control	0	<	1.0	1	Blood	0.5	
360	VB-03-0267	10	Control	0		4.0	1	Blood	4.0	
311	VB-03-0289	1	PbAc	25	<	1.0	2	Blood	0.5	
326	VB-03-0313	1	PbAc	25	<	1.0	2	Blood	0.5	
338	VB-03-0311	1	PbAc	25	<	1.0	2	Blood	0.5	
343	VB-03-0319	1	PbAc	25	<	1.0	2	Blood	0.5	
349	VB-03-0302	1	PbAc	25		17.0	2	Blood	17.0	
304	VB-03-0295	2	PbAc	75		2.0	2	Blood	2.0	
307	VB-03-0323	2	PbAc	75		2.0	2	Blood	2.0	
312	VB-03-0306	2	PbAc	75		3.0	2	Blood	3.0	
314	VB-03-0304	2	PbAc	75		2.0	2	Blood	2.0	
350	VB-03-0280	2	PbAc	75		2.0	2	Blood	2.0	
302	VB-03-0288	3	PbAc	225		4.0	2	Blood	4.0	
303	VB-03-0305	3	PbAc	225		4.9	2	Blood	4.9	
322	VB-03-0309	3	PbAc	225		6.3	2	Blood	6.3	
327	VB-03-0307	3	PbAc	225		4.2	2	Blood	4.2	
342	VB-03-0330	3	PbAc	225		1.0	2	Blood	1.0	
313	VB-03-0301	4	Site 1	75		1.0	2	Blood	1.0	
328	VB-03-0283	4	Site 1	75		1.0	2	Blood	1.0	
329	VB-03-0298	4	Site 1	75		1.0	2	Blood	1.0	
333	VB-03-0326	4	Site 1	75		2.0	2	Blood	2.0	
348	VB-03-0320	4	Site 1	75		1.0	2	Blood	1.0	
317	VB-03-0279	5	Site 1	225		3.6	2	Blood	3.6	
324	VB-03-0285	5	Site 1	225		4.9	2	Blood	4.9	
340	VB-03-0324	5	Site 1	225		3.1	2	Blood	3.1	
341	VB-03-0312	5	Site 1	225		4.7	2	Blood	4.7	
354	VB-03-0292	5	Site 1	225		3.0	2	Blood	3.0	
321	VB-03-0325	6	Site 1	500		5.7	2	Blood	5.7	
332	VB-03-0314	6	Site 1	500		4.6	2	Blood	4.6	
335	VB-03-0322	6	Site 1	500		3.8	2	Blood	3.8	
355	VB-03-0286	6	Site 1	500		7.8	2	Blood	7.8	
363	VB-03-0310	6	Site 1	500		5.2	2	Blood	5.2	
305	VB-03-0300	7	Site 2	75		2.0	2	Blood	2.0	
306	VB-03-0331	7	Site 2	75		29.0	2	Blood	29.0	
316	VB-03-0294	7	Site 2	75		2.0	2	Blood	2.0	
320	VB-03-0293	7	Site 2	75		2.0	2	Blood	2.0	
347	VB-03-0318	7	Site 2	75	<	1.0	2	Blood	0.5	
301	VB-03-0299	8	Site 2	225		3.0	2	Blood	3.0	
318	VB-03-0321	8	Site 2	225		2.0	2	Blood	2.0	
352	VB-03-0281	8	Site 2	225		3.7	2	Blood	3.7	
356	VB-03-0282	8	Site 2	225		2.0	2	Blood	2.0	
358	VB-03-0317	8	Site 2	225		5.0	2	Blood	5.0	
309	VB-03-0287	9	Site 2	500		6.7	2	Blood	6.7	
330	VB-03-0303	9	Site 2	500		6.3	2	Blood	6.3	
351	VB-03-0327	9	Site 2	500		3.9	2	Blood	3.9	
353	VB-03-0296	9	Site 2	500		5.9	2	Blood	5.9	
359	VB-03-0315	9	Site 2	500		4.4	2	Blood	4.4	
325	VB-03-0316	10	Control	0	<	1.0	2	Blood	0.5	
337	VB-03-0308	10	Control	0	<	1.0	2	Blood	0.5	
360	VB-03-0290	10	Control	0		2.0	2	Blood	2.0	
311	VB-03-0356	1	PbAc	25	<	1.0	3	Blood	0.5	
326	VB-03-0337	1	PbAc	25		2.8	3	Blood	2.8	
338	VB-03-0342	1	PbAc	25	<	1.0	3	Blood	0.5	
343	VB-03-0371	1	PbAc	25		0.9	3	Blood	0.9	
349	VB-03-0380	1	PbAc	25		1.0	3	Blood	1.0	
304	VB-03-0381	2	PbAc	75		2.6	3	Blood	2.6	
307	VB-03-0361	2	PbAc	75		3.2	3	Blood	3.2	
312	VB-03-0370	2	PbAc	75		3.8	3	Blood	3.8	
314	VB-03-0343	2	PbAc	75		2.0	3	Blood	2.0	
350	VB-03-0357	2	PbAc	75		2.4	3	Blood	2.4	
302	VB-03-0339	3	PbAc	225		4.5	3	Blood	4.5	
303	VB-03-0369	3	PbAc	225		6.7	3	Blood	6.7	
322	VB-03-0352	3	PbAc	225		6.4	3	Blood	6.4	
327	VB-03-0374	3	PbAc	225		5.0	3	Blood	5.0	
342	VB-03-0349	3	PbAc	225		4.0	3	Blood	4.0	
313	VB-03-0340	4	Site 1	75		1.6	3	Blood	1.6	
328	VB-03-0363	4	Site 1	75		1.3	3	Blood	1.3	
329	VB-03-0344	4	Site 1	75		4.7	3	Blood	4.7	
333	VB-03-0338	4	Site 1	75		6.7	3	Blood	6.7	
348	VB-03-0379	4	Site 1	75		2.2	3	Blood	2.2	
317	VB-03-0378	5	Site 1	225		3.6	3	Blood	3.6	
324	VB-03-0372	5	Site 1	225		5.2	3	Blood	5.2	
340	VB-03-0351	5	Site 1	225		4.1	3	Blood	4.1	
341	VB-03-0353	5	Site 1	225		4.7	3	Blood	4.7	
354	VB-03-0341	5	Site 1	225		3.3	3	Blood	3.3	
321	VB-03-0368	6	Site 1	500		7.7	3	Blood	7.7	
332	VB-03-0355	6	Site 1	500		3.8	3	Blood	3.8	
335	VB-03-0364	6	Site 1	500		3.7	3	Blood	3.7	
355	VB-03-0367	6	Site 1	500		10.1	3	Blood	10.1	
363	VB-03-0350	6	Site 1	500		6.4	3	Blood	6.4	
305	VB-03-0336	7	Site 2	75		1.5	3	Blood	1.5	
306	VB-03-0332	7	Site 2	75		2.6	3	Blood	2.6	
316	VB-03-0333	7	Site 2	75		2.5	3	Blood	2.5	
320	VB-03-0348	7	Site 2	75		1.3	3	Blood	1.3	
347	VB-03-0347	7	Site 2	75	<	1.0	3	Blood	0.5	
301	VB-03-0354	8	Site 2	225		3.8	3	Blood	3.8	
318	VB-03-0376	8	Site 2	225		3.5	3	Blood	3.5	
352	VB-03-0362	8	Site 2	225		3.8	3	Blood	3.8	
356	VB-03-0366	8	Site 2	225		3.1	3	Blood	3.1	
358	VB-03-0345	8	Site 2	225		4.6	3	Blood	4.6	
309	VB-03-0360	9	Site 2	500		7.1	3	Blood	7.1	

pig number	sample	group	material administered	dosage	qualifier	result	day	MATRIX	Adjusted Value ( ) <sup>a</sup>	Notes
330	VB-03-0335	9	Site 2	500		7.3	3	Blood	7.3	
351	VB-03-0358	9	Site 2	500		4.6	3	Blood	4.6	
353	VB-03-0359	9	Site 2	500		11.0	3	Blood	11.0	
359	VB-03-0365	9	Site 2	500		5.6	3	Blood	5.6	
325	VB-03-0377	10	Control	0	<	1.0	3	Blood	0.5	
337	VB-03-0375	10	Control	0	<	1.0	3	Blood	0.5	
360	VB-03-0383	10	Control	0	<	1.0	3	Blood	0.5	
311	VB-03-0406	1	PbAc	25	<	1.0	5	Blood	0.5	
326	VB-03-0388	1	PbAc	25		1.3	5	Blood	1.3	
338	VB-03-0400	1	PbAc	25	<	1.0	5	Blood	0.5	
343	VB-03-0391	1	PbAc	25		1.4	5	Blood	1.4	
349	VB-03-0428	1	PbAc	25		1.2	5	Blood	1.2	
304	VB-03-0424	2	PbAc	75		2.8	5	Blood	2.8	
307	VB-03-0390	2	PbAc	75		1.9	5	Blood	1.9	
312	VB-03-0437	2	PbAc	75		4.5	5	Blood	4.5	
314	VB-03-0416	2	PbAc	75		2.0	5	Blood	2.0	
350	VB-03-0385	2	PbAc	75		2.8	5	Blood	2.8	
302	VB-03-0417	3	PbAc	225		7.1	5	Blood	7.1	
303	VB-03-0399	3	PbAc	225		6.3	5	Blood	6.3	
322	VB-03-0407	3	PbAc	225		7.3	5	Blood	7.3	
327	VB-03-0420	3	PbAc	225		6.3	5	Blood	6.3	
342	VB-03-0413	3	PbAc	225		3.6	5	Blood	3.6	
313	VB-03-0395	4	Site 1	75		1.7	5	Blood	1.7	
328	VB-03-0401	4	Site 1	75		1.0	5	Blood	1.0	
329	VB-03-0412	4	Site 1	75		2.6	5	Blood	2.6	
333	VB-03-0415	4	Site 1	75		2.9	5	Blood	2.9	
348	VB-03-0436	4	Site 1	75		2.2	5	Blood	2.2	
317	VB-03-0403	5	Site 1	225		4.6	5	Blood	4.6	
324	VB-03-0411	5	Site 1	225		4.9	5	Blood	4.9	
340	VB-03-0394	5	Site 1	225		3.5	5	Blood	3.5	
341	VB-03-0410	5	Site 1	225		6.5	5	Blood	6.5	
354	VB-03-0434	5	Site 1	225		5.4	5	Blood	5.4	
321	VB-03-0392	6	Site 1	500		12.0	5	Blood	12.0	
332	VB-03-0409	6	Site 1	500		4.7	5	Blood	4.7	
335	VB-03-0418	6	Site 1	500		5.1	5	Blood	5.1	
355	VB-03-0405	6	Site 1	500		9.2	5	Blood	9.2	
363	VB-03-0404	6	Site 1	500		6.8	5	Blood	6.8	
305	VB-03-0398	7	Site 2	75		2.6	5	Blood	2.6	
306	VB-03-0422	7	Site 2	75		1.7	5	Blood	1.7	
316	VB-03-0389	7	Site 2	75		2.6	5	Blood	2.6	
320	VB-03-0408	7	Site 2	75		1.2	5	Blood	1.2	
347	VB-03-0397	7	Site 2	75		1.1	5	Blood	1.1	
301	VB-03-0414	8	Site 2	225		5.2	5	Blood	5.2	
318	VB-03-0431	8	Site 2	225		5.4	5	Blood	5.4	
352	VB-03-0430	8	Site 2	225		6.7	5	Blood	6.7	
356	VB-03-0425	8	Site 2	225		3.7	5	Blood	3.7	
358	VB-03-0393	8	Site 2	225		5.8	5	Blood	5.8	
309	VB-03-0387	9	Site 2	500		7.7	5	Blood	7.7	
330	VB-03-0433	9	Site 2	500		7.9	5	Blood	7.9	
351	VB-03-0423	9	Site 2	500		5.9	5	Blood	5.9	
353	VB-03-0396	9	Site 2	500		6.6	5	Blood	6.6	
359	VB-03-0402	9	Site 2	500		7.4	5	Blood	7.4	
325	VB-03-0386	10	Control	0	<	1.0	5	Blood	0.5	
337	VB-03-0419	10	Control	0	<	1.0	5	Blood	0.5	
360	VB-03-0426	10	Control	0	<	1.0	5	Blood	0.5	
311	VB-03-0484	1	PbAc	25	<	1.0	7	Blood	0.5	
326	VB-03-0460	1	PbAc	25		1.0	7	Blood	1.0	
338	VB-03-0451	1	PbAc	25		1.3	7	Blood	1.3	
343	VB-03-0448	1	PbAc	25	<	1.0	7	Blood	0.5	
349	VB-03-0439	1	PbAc	25		1.9	7	Blood	1.9	
304	VB-03-0465	2	PbAc	75		3.8	7	Blood	3.8	
307	VB-03-0447	2	PbAc	75		1.7	7	Blood	1.7	
312	VB-03-0467	2	PbAc	75		5.2	7	Blood	5.2	
314	VB-03-0446	2	PbAc	75		2.7	7	Blood	2.7	
350	VB-03-0478	2	PbAc	75		2.4	7	Blood	2.4	
302	VB-03-0472	3	PbAc	225		6.9	7	Blood	6.9	
303	VB-03-0462	3	PbAc	225		6.3	7	Blood	6.3	
322	VB-03-0441	3	PbAc	225		8.1	7	Blood	8.1	
327	VB-03-0468	3	PbAc	225		6.8	7	Blood	6.8	
342	VB-03-0469	3	PbAc	225		7.9	7	Blood	7.9	
313	VB-03-0485	4	Site 1	75		2.2	7	Blood	2.2	
328	VB-03-0471	4	Site 1	75		1.8	7	Blood	1.8	
329	VB-03-0487	4	Site 1	75		3.5	7	Blood	3.5	
333	VB-03-0457	4	Site 1	75		2.9	7	Blood	2.9	
348	VB-03-0480	4	Site 1	75		3.0	7	Blood	3.0	
317	VB-03-0456	5	Site 1	225		5.7	7	Blood	5.7	
324	VB-03-0476	5	Site 1	225		7.0	7	Blood	7.0	
340	VB-03-0450	5	Site 1	225		4.5	7	Blood	4.5	
341	VB-03-0466	5	Site 1	225		9.6	7	Blood	9.6	
354	VB-03-0461	5	Site 1	225		7.8	7	Blood	7.8	
321	VB-03-0473	6	Site 1	500		8.2	7	Blood	8.2	
332	VB-03-0490	6	Site 1	500		7.0	7	Blood	7.0	
335	VB-03-0442	6	Site 1	500		6.6	7	Blood	6.6	
355	VB-03-0443	6	Site 1	500		9.8	7	Blood	9.8	
363	VB-03-0486	6	Site 1	500		6.5	7	Blood	6.5	
305	VB-03-0489	7	Site 2	75		3.3	7	Blood	3.3	
306	VB-03-0459	7	Site 2	75		3.7	7	Blood	3.7	
316	VB-03-0440	7	Site 2	75		2.8	7	Blood	2.8	
320	VB-03-0455	7	Site 2	75		2.5	7	Blood	2.5	
347	VB-03-0481	7	Site 2	75		1.5	7	Blood	1.5	
301	VB-03-0454	8	Site 2	225		8.0	7	Blood	8.0	
318	VB-03-0458	8	Site 2	225		6.3	7	Blood	6.3	
352	VB-03-0477	8	Site 2	225		7.4	7	Blood	7.4	
356	VB-03-0453	8	Site 2	225		3.6	7	Blood	3.6	

pig number	sample	group	material administered	dosage	qualifier	result	day	MATRIX	Adjusted Value ( ) <sup>a</sup>	Notes
358	VB-03-0470	8	Site 2	225		7.4	7	Blood	7.4	
309	VB-03-0475	9	Site 2	500		8.2	7	Blood	8.2	
330	VB-03-0482	9	Site 2	500		9.7	7	Blood	9.7	
351	VB-03-0474	9	Site 2	500		6.5	7	Blood	6.5	
353	VB-03-0445	9	Site 2	500		8.5	7	Blood	8.5	
359	VB-03-0438	9	Site 2	500		9.5	7	Blood	9.5	
325	VB-03-0463	10	Control	0	<	1.0	7	Blood	0.5	
337	VB-03-0464	10	Control	0	<	1.0	7	Blood	0.5	
360	VB-03-0479	10	Control	0	<	1.0	7	Blood	0.5	
311	VB-03-0518	1	PbAc	25		1.9	9	Blood	1.9	
326	VB-03-0501	1	PbAc	25		2.0	9	Blood	2.0	
338	VB-03-0511	1	PbAc	25		2.2	9	Blood	2.2	
343	VB-03-0521	1	PbAc	25		2.2	9	Blood	2.2	
349	VB-03-0529	1	PbAc	25		2.4	9	Blood	2.4	
304	VB-03-0509	2	PbAc	75		4.3	9	Blood	4.3	
307	VB-03-0535	2	PbAc	75		3.7	9	Blood	3.7	
312	VB-03-0531	2	PbAc	75		5.4	9	Blood	5.4	
314	VB-03-0499	2	PbAc	75		3.5	9	Blood	3.5	
350	VB-03-0502	2	PbAc	75		3.5	9	Blood	3.5	
302	VB-03-0495	3	PbAc	225		7.8	9	Blood	7.8	
303	VB-03-0512	3	PbAc	225		7.6	9	Blood	7.6	
322	VB-03-0514	3	PbAc	225		9.9	9	Blood	9.9	
327	VB-03-0540	3	PbAc	225		7.2	9	Blood	7.2	
342	VB-03-0526	3	PbAc	225		9.4	9	Blood	9.4	
313	VB-03-0510	4	Site 1	75		2.9	9	Blood	2.9	
328	VB-03-0494	4	Site 1	75		2.6	9	Blood	2.6	
329	VB-03-0500	4	Site 1	75		4.0	9	Blood	4.0	
333	VB-03-0528	4	Site 1	75		3.8	9	Blood	3.8	
348	VB-03-0534	4	Site 1	75		5.3	9	Blood	5.3	
317	VB-03-0496	5	Site 1	225		7.3	9	Blood	7.3	
324	VB-03-0530	5	Site 1	225		8.0	9	Blood	8.0	
340	VB-03-0538	5	Site 1	225		5.1	9	Blood	5.1	
341	VB-03-0492	5	Site 1	225		10.5	9	Blood	10.5	
354	VB-03-0522	5	Site 1	225		10.1	9	Blood	10.1	
321	VB-03-0541	6	Site 1	500		11.3	9	Blood	11.3	
332	VB-03-0523	6	Site 1	500		10.0	9	Blood	10.0	
335	VB-03-0515	6	Site 1	500		8.6	9	Blood	8.6	
355	VB-03-0537	6	Site 1	500		11.7	9	Blood	11.7	
363	VB-03-0505	6	Site 1	500		9.5	9	Blood	9.5	
305	VB-03-0507	7	Site 2	75		4.4	9	Blood	4.4	
306	VB-03-0520	7	Site 2	75		4.4	9	Blood	4.4	
316	VB-03-0539	7	Site 2	75		3.1	9	Blood	3.1	
320	VB-03-0543	7	Site 2	75		2.8	9	Blood	2.8	
347	VB-03-0542	7	Site 2	75		1.7	9	Blood	1.7	
301	VB-03-0498	8	Site 2	225		6.2	9	Blood	6.2	
318	VB-03-0504	8	Site 2	225		7.3	9	Blood	7.3	
352	VB-03-0491	8	Site 2	225		11.4	9	Blood	11.4	
356	VB-03-0503	8	Site 2	225		4.7	9	Blood	4.7	
358	VB-03-0532	8	Site 2	225		9.2	9	Blood	9.2	
309	VB-03-0493	9	Site 2	500		11.3	9	Blood	11.3	
330	VB-03-0536	9	Site 2	500		10.4	9	Blood	10.4	
351	VB-03-0513	9	Site 2	500		9.4	9	Blood	9.4	
353	VB-03-0497	9	Site 2	500		10.9	9	Blood	10.9	
359	VB-03-0527	9	Site 2	500		11.4	9	Blood	11.4	
325	VB-03-0506	10	Control	0	<	1.0	9	Blood	0.5	
337	VB-03-0525	10	Control	0	<	1.0	9	Blood	0.5	
360	VB-03-0519	10	Control	0	<	1.0	9	Blood	0.5	
311	VB-03-0590	1	PbAc	25		2.0	12	Blood	2.0	
326	VB-03-0552	1	PbAc	25		2.9	12	Blood	2.9	
338	VB-03-0545	1	PbAc	25		3.5	12	Blood	3.5	
343	VB-03-0584	1	PbAc	25		2.2	12	Blood	2.2	
349	VB-03-0589	1	PbAc	25		2.9	12	Blood	2.9	
304	VB-03-0564	2	PbAc	75		5.5	12	Blood	5.5	
307	VB-03-0555	2	PbAc	75		4.7	12	Blood	4.7	
312	VB-03-0549	2	PbAc	75		5.9	12	Blood	5.9	
314	VB-03-0559	2	PbAc	75		3.2	12	Blood	3.2	
350	VB-03-0585	2	PbAc	75		4.8	12	Blood	4.8	
302	VB-03-0591	3	PbAc	225		9.7	12	Blood	9.7	
303	VB-03-0550	3	PbAc	225		9.1	12	Blood	9.1	
322	VB-03-0568	3	PbAc	225		11.1	12	Blood	11.1	
327	VB-03-0556	3	PbAc	225		9.4	12	Blood	9.4	
342	VB-03-0573	3	PbAc	225		12.0	12	Blood	12.0	
313	VB-03-0566	4	Site 1	75		3.8	12	Blood	3.8	
328	VB-03-0572	4	Site 1	75		9.9	12	Blood	9.9	
329	VB-03-0582	4	Site 1	75		4.4	12	Blood	4.4	
333	VB-03-0596	4	Site 1	75		5.0	12	Blood	5.0	
348	VB-03-0593	4	Site 1	75		4.7	12	Blood	4.7	
317	VB-03-0579	5	Site 1	225		8.8	12	Blood	8.8	
324	VB-03-0558	5	Site 1	225		9.6	12	Blood	9.6	
340	VB-03-0586	5	Site 1	225		6.2	12	Blood	6.2	
341	VB-03-0557	5	Site 1	225		9.7	12	Blood	9.7	
354	VB-03-0595	5	Site 1	225		10.2	12	Blood	10.2	
321	VB-03-0588	6	Site 1	500		17.0	12	Blood	17.0	
332	VB-03-0594	6	Site 1	500		11.4	12	Blood	11.4	
335	VB-03-0569	6	Site 1	500		9.9	12	Blood	9.9	
355	VB-03-0561	6	Site 1	500		13.6	12	Blood	13.6	
363	VB-03-0563	6	Site 1	500		10.0	12	Blood	10.0	
305	VB-03-0548	7	Site 2	75		4.5	12	Blood	4.5	
306	VB-03-0576	7	Site 2	75		4.6	12	Blood	4.6	
316	VB-03-0562	7	Site 2	75		4.0	12	Blood	4.0	
320	VB-03-0581	7	Site 2	75		5.2	12	Blood	5.2	
347	VB-03-0587	7	Site 2	75		3.3	12	Blood	3.3	
301	VB-03-0575	8	Site 2	225		7.1	12	Blood	7.1	
318	VB-03-0551	8	Site 2	225		9.0	12	Blood	9.0	

pig number	sample	group	material administered	dosage	qualifier	result	day	MATRIX	Adjusted Value ( ) <sup>a</sup>	Notes
352	VB-03-0592	8	Site 2	225		12.0	12	Blood	12.0	
356	VB-03-0554	8	Site 2	225		6.4	12	Blood	6.4	
358	VB-03-0547	8	Site 2	225		8.9	12	Blood	8.9	
309	VB-03-0571	9	Site 2	500		12.2	12	Blood	12.2	
330	VB-03-0570	9	Site 2	500		12.0	12	Blood	12.0	
351	VB-03-0553	9	Site 2	500		10.2	12	Blood	10.2	
353	VB-03-0565	9	Site 2	500		11.1	12	Blood	11.1	
359	VB-03-0574	9	Site 2	500		13.3	12	Blood	13.3	
325	VB-03-0560	10	Control	0		1.5	12	Blood	1.5	
337	VB-03-0577	10	Control	0	<	1.0	12	Blood	0.5	
360	VB-03-0544	10	Control	0	<	1.0	12	Blood	0.5	
311	VB-03-0635	1	PbAc	25		2.0	15	Blood	2.0	
326	VB-03-0616	1	PbAc	25		3.2	15	Blood	3.2	
338	VB-03-0649	1	PbAc	25		2.8	15	Blood	2.8	
343	VB-03-0622	1	PbAc	25		2.5	15	Blood	2.5	
349	VB-03-0605	1	PbAc	25		3.1	15	Blood	3.1	
304	VB-03-0618	2	PbAc	75		6.3	15	Blood	6.3	
307	VB-03-0610	2	PbAc	75		4.4	15	Blood	4.4	
312	VB-03-0625	2	PbAc	75		4.9	15	Blood	4.9	
314	VB-03-0601	2	PbAc	75		3.6	15	Blood	3.6	
350	VB-03-0608	2	PbAc	75		4.5	15	Blood	4.5	
302	VB-03-0604	3	PbAc	225		9.7	15	Blood	9.7	
303	VB-03-0613	3	PbAc	225		9.1	15	Blood	9.1	
322	VB-03-0629	3	PbAc	225		10.7	15	Blood	10.7	
327	VB-03-0645	3	PbAc	225		7.8	15	Blood	7.8	
342	VB-03-0602	3	PbAc	225		9.0	15	Blood	9.0	
313	VB-03-0626	4	Site 1	75		2.5	15	Blood	2.5	
328	VB-03-0598	4	Site 1	75		3.0	15	Blood	3.0	
329	VB-03-0640	4	Site 1	75		4.0	15	Blood	4.0	
333	VB-03-0623	4	Site 1	75		3.6	15	Blood	3.6	
348	VB-03-0634	4	Site 1	75		4.8	15	Blood	4.8	
317	VB-03-0630	5	Site 1	225		9.4	15	Blood	9.4	
324	VB-03-0614	5	Site 1	225		9.5	15	Blood	9.5	
340	VB-03-0597	5	Site 1	225		5.5	15	Blood	5.5	
341	VB-03-0621	5	Site 1	225		13.0	15	Blood	13.0	
354	VB-03-0644	5	Site 1	225		10.9	15	Blood	10.9	
321	VB-03-0600	6	Site 1	500		13.0	15	Blood	13.0	
332	VB-03-0647	6	Site 1	500		14.6	15	Blood	14.6	
335	VB-03-0641	6	Site 1	500		11.1	15	Blood	11.1	
355	VB-03-0603	6	Site 1	500		13.5	15	Blood	13.5	
363	VB-03-0611	6	Site 1	500		11.2	15	Blood	11.2	
305	VB-03-0620	7	Site 2	75		5.7	15	Blood	5.7	
306	VB-03-0606	7	Site 2	75		5.2	15	Blood	5.2	
316	VB-03-0642	7	Site 2	75		4.0	15	Blood	4.0	
320	VB-03-0619	7	Site 2	75		5.3	15	Blood	5.3	
347	VB-03-0643	7	Site 2	75		2.8	15	Blood	2.8	
301	VB-03-0607	8	Site 2	225		7.9	15	Blood	7.9	
318	VB-03-0646	8	Site 2	225		10.2	15	Blood	10.2	
352	VB-03-0612	8	Site 2	225		11.0	15	Blood	11.0	
356	VB-03-0631	8	Site 2	225		6.3	15	Blood	6.3	
358	VB-03-0636	8	Site 2	225		8.0	15	Blood	8.0	
309	VB-03-0599	9	Site 2	500		13.1	15	Blood	13.1	
330	VB-03-0617	9	Site 2	500		16.2	15	Blood	16.2	
351	VB-03-0627	9	Site 2	500		10.8	15	Blood	10.8	
353	VB-03-0615	9	Site 2	500		12.1	15	Blood	12.1	
359	VB-03-0624	9	Site 2	500		12.7	15	Blood	12.7	
325	VB-03-0637	10	Control	0	<	1.0	15	Blood	0.5	
337	VB-03-0632	10	Control	0	<	1.0	15	Blood	0.5	
360	VB-03-0639	10	Control	0	<	1.0	15	Blood	0.5	

a Non-detects evaluated using 1/2 the quantitation limit; laboratory results (ug/L) converted to concentration in blood (ug/dL) by dividing by dilution factor of 1 dL/L

TABLE A-4 BLOOD LEAD OUTLIERS

Flagged Data Points  
Outliers

test material	target dosage	Actual Dose*	group	pig#	BLOOD LEAD (ug/dL) BY DAY								
					0	1	2	3	5	7	9	12	15
PbAc	25	24.87	1	311	0.5	0.5	0.5	0.5	0.5	0.5	1.9	2.0	2.0
PbAc	25	25.71	1	326	2.0	0.5	0.5	2.8	1.3	1.0	2.0	2.9	3.2
PbAc	25	23.68	1	338	0.5	0.5	0.5	0.5	0.5	1.3	2.2	3.5	2.8
PbAc	25	29.71	1	343	0.5	0.5	0.5	0.9	1.4	0.5	2.2	2.2	2.5
PbAc	25	25.86	1	349	0.5	0.5	17.0	1.0	1.2	1.9	2.4	2.9	3.1
PbAc	75	71.55	2	304	0.5	2.0	2.0	2.6	2.8	3.8	4.3	5.5	6.3
PbAc	75	81.04	2	307	0.5	2.0	2.0	3.2	1.9	1.7	3.7	4.7	4.4
PbAc	75	84.25	2	312	0.5	1.0	3.0	3.8	4.5	5.2	5.4	5.9	4.9
PbAc	75	78.61	2	314	0.5	2.0	2.0	2.0	2.0	2.7	3.5	3.2	3.6
PbAc	75	74.31	2	350	0.5	2.0	2.0	2.4	2.8	2.4	3.5	4.8	4.5
PbAc	225	245.25	3	302	0.5	2.0	4.0	4.5	7.1	6.9	7.8	9.7	9.7
PbAc	225	214.61	3	303	0.5	2.0	4.9	6.7	6.3	6.3	7.6	9.1	9.1
PbAc	225	226.51	3	322	0.5	4.7	6.3	6.4	7.3	8.1	9.9	11.1	10.7
PbAc	225	244.91	3	327	0.5	3.0	4.2	5.0	6.3	6.8	7.2	9.4	7.8
PbAc	225	234.34	3	342	0.5	1.0	1.0	4.0	3.6	7.9	9.4	12.0	9.0
TM1	75	74.00	4	313	0.5	0.5	1.0	1.6	1.7	2.2	2.9	3.8	2.5
TM1	75	78.38	4	328	0.5	1.0	1.0	1.3	1.0	1.8	2.6	9.9	3.0
TM1	75	79.96	4	329	0.5	0.5	1.0	4.7	2.6	3.5	4.0	4.4	4.0
TM1	75	81.93	4	333	0.5	2.0	2.0	6.7	2.9	2.9	3.8	5.0	3.6
TM1	75	71.79	4	348	0.5	1.0	1.0	2.2	2.2	3.0	5.3	4.7	4.8
TM1	225	238.91	5	317	0.5	3.0	3.6	3.6	4.6	5.7	7.3	8.8	9.4
TM1	225	248.21	5	324	0.5	3.6	4.9	5.2	4.9	7.0	8.0	9.6	9.5
TM1	225	229.97	5	340	0.5	2.0	3.1	4.1	3.5	4.5	5.1	6.2	5.5
TM1	225	244.68	5	341	0.5	5.2	4.7	4.7	6.5	9.6	10.5	9.7	13.0
TM1	225	198.39	5	354	0.5	2.0	3.0	3.3	5.4	7.8	10.1	10.2	10.9
TM1	500	534.79	6	321	0.5	4.0	5.7	7.7	12.0	8.2	11.3	17.0	13.0
TM1	500	506.85	6	332	8.1	3.1	4.6	3.8	4.7	7.0	10.0	11.4	14.6
TM1	500	475.24	6	335	0.5	3.2	3.8	3.7	5.1	6.6	8.6	9.9	11.1
TM1	500	536.63	6	355	0.5	6.9	7.8	10.1	9.2	9.8	11.7	13.6	13.5
TM1	500	511.79	6	363	0.5	4.0	5.2	6.4	6.8	6.5	9.5	10.0	11.2
TM2	75	79.95	7	305	0.5	0.5	2.0	1.5	2.6	3.3	4.4	4.5	5.7
TM2	75	74.54	7	306	0.5	1.0	29.0	2.6	1.7	3.7	4.4	4.6	5.2
TM2	75	79.36	7	316	0.5	1.0	2.0	2.5	2.6	2.8	3.1	4.0	4.0
TM2	75	78.01	7	320	0.5	1.0	2.0	1.3	1.2	2.5	2.8	5.2	5.3
TM2	75	73.80	7	347	0.5	1.0	0.5	0.5	1.1	1.5	1.7	3.3	2.8
TM2	225	237.88	8	301	0.5	3.0	3.0	3.8	5.2	8.0	6.2	7.1	7.9
TM2	225	230.40	8	318	0.5	2.0	2.0	3.5	5.4	6.3	7.3	9.0	10.2
TM2	225	219.81	8	352	0.5	3.9	3.7	3.8	6.7	7.4	11.4	12.0	11.0
TM2	225	236.32	8	356	0.5	2.0	2.0	3.1	3.7	3.6	4.7	6.4	6.3
TM2	225	257.11	8	358	0.5	3.5	5.0	4.6	5.8	7.4	9.2	8.9	8.0
TM2	500	484.95	9	309	0.5	4.5	6.7	7.1	7.7	8.2	11.3	12.2	13.1
TM2	500	517.72	9	330	0.5	5.7	6.3	7.3	7.9	9.7	10.4	12.0	16.2
TM2	500	499.96	9	351	0.5	2.0	3.9	4.6	5.9	6.5	9.4	10.2	10.8
TM2	500	561.96	9	353	0.5	4.1	5.9	11.0	6.6	8.5	10.9	11.1	12.1
TM2	500	493.10	9	359	0.5	3.7	4.4	5.6	7.4	9.5	11.4	13.3	12.7
Control	0	0.00	10	325	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.5	0.5
Control	0	0.00	10	337	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Control	0	0.00	10	360	0.5	4.0	2.0	0.5	0.5	0.5	0.5	0.5	0.5

\* Average Time and Weight-Adjusted Dose for Each Pig

TABLE A-6 Area Under Curve Determinations

Calculated using interpolated values for excluded data as noted in Table A-5

group	pig#	AUC (ug/dL-days) For Time Span Shown								AUC Total (ug/dL-days)
		0-1	1-2	2-3	3-5	5-7	7-9	9-12	12-15	
1	311	0.50	0.50	0.50	1.00	1.00	2.40	5.85	6.00	17.75
1	326	1.25	0.50	1.65	4.10	2.30	3.00	7.35	9.15	29.30
1	338	0.50	0.50	0.50	1.00	1.80	3.50	8.55	9.45	25.80
1	343	0.50	0.50	0.70	2.30	1.90	2.70	6.60	7.05	22.25
1	349	0.50	0.63	0.88	2.20	3.10	4.30	7.95	9.00	28.55
2	304	1.25	2.00	2.30	5.40	6.60	8.10	14.70	17.70	58.05
2	307	1.25	2.00	2.60	5.10	3.60	5.40	12.60	13.65	46.20
2	312	0.75	2.00	3.40	8.30	9.70	10.60	16.95	16.20	67.90
2	314	1.25	2.00	2.00	4.00	4.70	6.20	10.05	10.20	40.40
2	350	1.25	2.00	2.20	5.20	5.20	5.90	12.45	13.95	48.15
3	302	1.25	3.00	4.25	11.60	14.00	14.70	26.25	29.10	104.15
3	303	1.25	3.45	5.80	13.00	12.60	13.90	25.05	27.30	102.35
3	322	2.60	5.50	6.35	13.70	15.40	18.00	31.50	32.70	125.75
3	327	1.75	3.60	4.60	11.30	13.10	14.00	24.90	25.80	99.05
3	342	0.75	1.00	2.50	7.60	11.50	17.30	32.10	31.50	104.25
4	313	0.50	0.75	1.30	3.30	3.90	5.10	10.05	9.45	34.35
4	328	0.75	1.00	1.15	2.30	2.80	4.40	8.10	8.70	29.20
4	329	0.50	0.75	2.85	7.30	6.10	7.50	12.60	12.60	50.20
4	333	1.25	2.00	4.35	9.60	5.80	6.70	13.20	12.90	55.80
4	348	0.75	1.00	1.60	4.40	5.20	8.30	15.00	14.25	50.50
5	317	1.75	3.30	3.60	8.20	10.30	13.00	24.15	27.30	91.60
5	324	2.05	4.25	5.05	10.10	11.90	15.00	26.40	28.65	103.40
5	340	1.25	2.55	3.60	7.60	8.00	9.60	16.95	17.55	67.10
5	341	2.85	4.95	4.70	11.20	16.10	20.10	30.30	34.05	124.25
5	354	1.25	2.50	3.15	8.70	13.20	17.90	30.45	31.65	108.80
6	321	2.25	4.85	6.70	15.65	16.15	19.50	42.45	45.00	152.55
6	332	1.80	3.85	4.20	8.50	11.70	17.00	32.10	39.00	118.15
6	335	1.85	3.50	3.75	8.80	11.70	15.20	27.75	31.50	104.05
6	355	3.70	7.35	8.95	19.30	19.00	21.50	37.95	40.65	158.40
6	363	2.25	4.60	5.80	13.20	13.30	16.00	29.25	31.80	116.20
7	305	0.50	1.25	1.75	4.10	5.90	7.70	13.35	15.30	49.85
7	306	0.75	1.40	2.20	4.30	5.40	8.10	13.50	14.70	50.35
7	316	0.75	1.50	2.25	5.10	5.40	5.90	10.65	12.00	43.55
7	320	0.75	1.50	1.65	2.50	3.70	5.30	12.00	15.75	43.15
7	347	0.75	0.75	0.50	1.60	2.60	3.20	7.50	9.15	26.05
8	301	1.75	3.00	3.40	9.00	13.20	14.20	19.95	22.50	87.00
8	318	1.25	2.00	2.75	8.90	11.70	13.60	24.45	28.80	93.45
8	352	2.20	3.80	3.75	10.50	14.10	18.80	35.10	34.50	122.75
8	356	1.25	2.00	2.55	6.80	7.30	8.30	16.65	19.05	63.90
8	358	2.00	4.25	4.80	10.40	13.20	16.60	27.15	25.35	103.75
9	309	2.50	5.60	6.90	14.80	15.90	19.50	35.25	37.95	138.40
9	330	3.10	6.00	6.80	15.20	17.60	20.10	33.60	42.30	144.70
9	351	1.25	2.95	4.25	10.50	12.40	15.90	29.40	31.50	108.15
9	353	2.30	5.00	8.45	17.60	15.10	19.40	33.00	34.80	135.65
9	359	2.10	4.05	5.00	13.00	16.90	20.90	37.05	39.00	138.00
10	325	0.50	0.50	0.50	1.00	1.00	1.00	3.00	3.00	10.50
10	337	0.50	0.50	0.50	1.00	1.00	1.00	1.50	1.50	7.50
10	360	2.25	3.00	1.25	1.00	1.00	1.00	1.50	1.50	12.50

TABLE A - 7 TISSUE LEAD DATA

pig number	sample	group	material administered	dosage	qualifier	result	day	MATRIX	Adjusted Value ( ) <sup>a</sup>	Notes
311	VB-03-0689	1	PbAc	25		4.8	15	femur	2.4	
326	VB-03-0669	1	PbAc	25		5.4	15	femur	2.7	
338	VB-03-0667	1	PbAc	25		5.0	15	femur	2.5	
343	VB-03-0672	1	PbAc	25		5.0	15	femur	2.5	
349	VB-03-0674	1	PbAc	25		5.4	15	femur	2.7	
304	VB-03-0680	2	PbAc	75		8.5	15	femur	4.3	
307	VB-03-0693	2	PbAc	75		13.0	15	femur	6.5	
312	VB-03-0687	2	PbAc	75		9.5	15	femur	4.8	
314	VB-03-0653	2	PbAc	75		14.0	15	femur	7.0	
350	VB-03-0683	2	PbAc	75		8.2	15	femur	4.1	
302	VB-03-0679	3	PbAc	225		39.0	15	femur	19.5	
303	VB-03-0665	3	PbAc	225		36.0	15	femur	18.0	
322	VB-03-0695	3	PbAc	225		33.0	15	femur	16.5	
327	VB-03-0657	3	PbAc	225		39.0	15	femur	19.5	
342	VB-03-0686	3	PbAc	225		30.0	15	femur	15.0	
313	VB-03-0676	4	Site 1	75		7.5	15	femur	3.8	
328	VB-03-0694	4	Site 1	75		7.3	15	femur	3.7	
329	VB-03-0685	4	Site 1	75		11.0	15	femur	5.5	
333	VB-03-0655	4	Site 1	75		7.9	15	femur	4.0	
348	VB-03-0677	4	Site 1	75		43.0	15	femur	21.5	
317	VB-03-0688	5	Site 1	225		29.0	15	femur	14.5	
324	VB-03-0656	5	Site 1	225		25.0	15	femur	12.5	
340	VB-03-0659	5	Site 1	225		22.0	15	femur	11.0	
341	VB-03-0692	5	Site 1	225		29.0	15	femur	14.5	
354	VB-03-0700	5	Site 1	225		20.0	15	femur	10.0	
321	VB-03-0681	6	Site 1	500		56.0	15	femur	28.0	
332	VB-03-0697	6	Site 1	500		48.0	15	femur	24.0	
335	VB-03-0652	6	Site 1	500		35.0	15	femur	17.5	
355	VB-03-0664	6	Site 1	500		48.0	15	femur	24.0	
363	VB-03-0661	6	Site 1	500		57.0	15	femur	28.5	
305	VB-03-0658	7	Site 2	75		13.0	15	femur	6.5	
306	VB-03-0698	7	Site 2	75		9.5	15	femur	4.8	
316	VB-03-0650	7	Site 2	75		11.0	15	femur	5.5	
320	VB-03-0670	7	Site 2	75		9.2	15	femur	4.6	
347	VB-03-0654	7	Site 2	75		5.6	15	femur	2.8	
301	VB-03-0662	8	Site 2	225		25.0	15	femur	12.5	
318	VB-03-0682	8	Site 2	225		8.0	15	femur	4.0	
352	VB-03-0666	8	Site 2	225		37.0	15	femur	18.5	
356	VB-03-0671	8	Site 2	225		23.0	15	femur	11.5	
358	VB-03-0663	8	Site 2	225		29.0	15	femur	14.5	
309	VB-03-0696	9	Site 2	500		38.0	15	femur	19.0	
330	VB-03-0668	9	Site 2	500		46.0	15	femur	23.0	
351	VB-03-0675	9	Site 2	500		36.0	15	femur	18.0	
353	VB-03-0690	9	Site 2	500		43.0	15	femur	21.5	
359	VB-03-0660	9	Site 2	500		40.0	15	femur	20.0	
325	VB-03-0678	10	Control	0	<	1.0	15	femur	0.3	
337	VB-03-0699	10	Control	0		1.0	15	femur	0.5	
360	VB-03-0684	10	Control	0		1.0	15	femur	0.5	
311	VB-03-0776	1	PbAc	25		4.8	15	kidney	48.0	
326	VB-03-0774	1	PbAc	25		7.3	15	kidney	73.0	
338	VB-03-0791	1	PbAc	25		3.0	15	kidney	30.0	
343	VB-03-0758	1	PbAc	25		4.4	15	kidney	44.0	
349	VB-03-0760	1	PbAc	25		4.9	15	kidney	49.0	
304	VB-03-0769	2	PbAc	75		12.0	15	kidney	120.0	
307	VB-03-0765	2	PbAc	75		15.0	15	kidney	150.0	
312	VB-03-0800	2	PbAc	75		12.0	15	kidney	120.0	
314	VB-03-0762	2	PbAc	75		11.0	15	kidney	110.0	
350	VB-03-0785	2	PbAc	75		14.0	15	kidney	140.0	
302	VB-03-0764	3	PbAc	225		34.0	15	kidney	340.0	
303	VB-03-0802	3	PbAc	225		37.0	15	kidney	370.0	
322	VB-03-0777	3	PbAc	225		56.0	15	kidney	560.0	
327	VB-03-0753	3	PbAc	225		36.0	15	kidney	360.0	
342	VB-03-0784	3	PbAc	225			15	kidney	#VALUE!	Missing
313	VB-03-0768	4	Site 1	75		7.4	15	kidney	74.0	
328	VB-03-0797	4	Site 1	75		11.0	15	kidney	110.0	
329	VB-03-0788	4	Site 1	75		10.0	15	kidney	100.0	
333	VB-03-0793	4	Site 1	75		8.9	15	kidney	89.0	
348	VB-03-0759	4	Site 1	75			15	kidney	#VALUE!	Missing
317	VB-03-0773	5	Site 1	225		37.0	15	kidney	370.0	
324	VB-03-0752	5	Site 1	225		34.0	15	kidney	340.0	
340	VB-03-0786	5	Site 1	225		23.0	15	kidney	230.0	
341	VB-03-0790	5	Site 1	225		41.0	15	kidney	410.0	
354	VB-03-0787	5	Site 1	225		41.0	15	kidney	410.0	
321	VB-03-0778	6	Site 1	500		95.0	15	kidney	950.0	
332	VB-03-0775	6	Site 1	500		92.0	15	kidney	920.0	
335	VB-03-0761	6	Site 1	500		53.0	15	kidney	530.0	
355	VB-03-0771	6	Site 1	500		58.0	15	kidney	580.0	
363	VB-03-0780	6	Site 1	500		75.0	15	kidney	750.0	
305	VB-03-0757	7	Site 2	75		14.0	15	kidney	140.0	
306	VB-03-0789	7	Site 2	75		8.4	15	kidney	84.0	
316	VB-03-0796	7	Site 2	75		8.8	15	kidney	88.0	
320	VB-03-0770	7	Site 2	75		10.0	15	kidney	100.0	
347	VB-03-0798	7	Site 2	75		4.3	15	kidney	43.0	

pig number	sample	group	material administered	dosage	qualifier	result	day	MATRIX	Adjusted Value ( ) <sup>a</sup>	Notes
301	VB-03-0781	8	Site 2	225		35.0	15	kidney	350.0	
318	VB-03-0779	8	Site 2	225			15	kidney	#VALUE!	Missing
352	VB-03-0794	8	Site 2	225		54.0	15	kidney	540.0	
356	VB-03-0767	8	Site 2	225		22.0	15	kidney	220.0	
358	VB-03-0772	8	Site 2	225		28.0	15	kidney	280.0	
309	VB-03-0792	9	Site 2	500		58.0	15	kidney	580.0	
330	VB-03-0754	9	Site 2	500		100.0	15	kidney	1000.0	
351	VB-03-0766	9	Site 2	500		54.0	15	kidney	540.0	
353	VB-03-0799	9	Site 2	500		56.0	15	kidney	560.0	
359	VB-03-0801	9	Site 2	500		64.0	15	kidney	640.0	
325	VB-03-0782	10	Control	0	<	1.0	15	kidney	5.0	
337	VB-03-0756	10	Control	0	<	1.0	15	kidney	5.0	
360	VB-03-0795	10	Control	0	<	1.0	15	kidney	5.0	
311	VB-03-0702	1	PbAc	25		8.7	15	liver	87.0	
326	VB-03-0717	1	PbAc	25		12.0	15	liver	120.0	
338	VB-03-0728	1	PbAc	25		9.7	15	liver	97.0	
343	VB-03-0701	1	PbAc	25		10.0	15	liver	100.0	
349	VB-03-0713	1	PbAc	25		8.6	15	liver	86.0	
304	VB-03-0708	2	PbAc	75		31.0	15	liver	310.0	
307	VB-03-0746	2	PbAc	75		20.0	15	liver	200.0	
312	VB-03-0744	2	PbAc	75		20.0	15	liver	200.0	
314	VB-03-0722	2	PbAc	75		16.0	15	liver	160.0	
350	VB-03-0706	2	PbAc	75		32.0	15	liver	320.0	
302	VB-03-0720	3	PbAc	225		54.0	15	liver	540.0	
303	VB-03-0743	3	PbAc	225		89.0	15	liver	890.0	
322	VB-03-0735	3	PbAc	225		70.0	15	liver	700.0	
327	VB-03-0724	3	PbAc	225		49.0	15	liver	490.0	
342	VB-03-0710	3	PbAc	225		100.0	15	liver	1000.0	
313	VB-03-0727	4	Site 1	75		9.0	15	liver	90.0	
328	VB-03-0703	4	Site 1	75		18.0	15	liver	180.0	
329	VB-03-0742	4	Site 1	75		13.0	15	liver	130.0	
333	VB-03-0721	4	Site 1	75		14.0	15	liver	140.0	
348	VB-03-0734	4	Site 1	75		14.0	15	liver	140.0	
317	VB-03-0736	5	Site 1	225		88.0	15	liver	880.0	
324	VB-03-0718	5	Site 1	225		86.0	15	liver	860.0	
340	VB-03-0715	5	Site 1	225		47.0	15	liver	470.0	
341	VB-03-0719	5	Site 1	225		110.0	15	liver	1100.0	
354	VB-03-0723	5	Site 1	225		61.0	15	liver	610.0	
321	VB-03-0749	6	Site 1	500		180.0	15	liver	1800.0	
332	VB-03-0704	6	Site 1	500		160.0	15	liver	1600.0	
335	VB-03-0716	6	Site 1	500		130.0	15	liver	1300.0	
355	VB-03-0740	6	Site 1	500		130.0	15	liver	1300.0	
363	VB-03-0726	6	Site 1	500		96.0	15	liver	960.0	
305	VB-03-0733	7	Site 2	75		18.0	15	liver	180.0	
306	VB-03-0748	7	Site 2	75		14.0	15	liver	140.0	
316	VB-03-0730	7	Site 2	75		15.0	15	liver	150.0	
320	VB-03-0741	7	Site 2	75		15.0	15	liver	150.0	
347	VB-03-0711	7	Site 2	75		11.0	15	liver	110.0	
301	VB-03-0709	8	Site 2	225		40.0	15	liver	400.0	
318	VB-03-0729	8	Site 2	225		76.0	15	liver	760.0	
352	VB-03-0731	8	Site 2	225		70.0	15	liver	700.0	
356	VB-03-0751	8	Site 2	225		35.0	15	liver	350.0	
358	VB-03-0747	8	Site 2	225		60.0	15	liver	600.0	
309	VB-03-0738	9	Site 2	500		120.0	15	liver	1200.0	
330	VB-03-0737	9	Site 2	500		230.0	15	liver	2300.0	
351	VB-03-0725	9	Site 2	500		97.0	15	liver	970.0	
353	VB-03-0732	9	Site 2	500		89.0	15	liver	890.0	
359	VB-03-0712	9	Site 2	500		120.0	15	liver	1200.0	
325	VB-03-0705	10	Control	0	<	1.0	15	liver	5.0	
337	VB-03-0739	10	Control	0	<	1.0	15	liver	10.0	
360	VB-03-0750	10	Control	0	<	1.0	15	liver	5.0	

<sup>a</sup> Non-detects evaluated using 1/2 the quantitation limit. Laboratory results (ug/L) converted to tissue concentrations by dividing by sample dilution factors of 0.1 kg/L (liver, kidney) or 2 g/L (ashed bone). Final units are ug Pb/kg wet weight (liver, kidney) or ug Pb/g ashed bone (femur)

TABLE A-8 SUMMARY OF ENDPOINT OUTLIERS

 Selected Outliers

test material	target dosage	Actual Dose*	group	pig#	MEASUREMENT ENDPOINT			
					Blood	Femur	Liver	Kidney
PbAc	25	24.87	1	311	17.8	2.4	87	48
PbAc	25	25.71	1	326	29.3	2.7	120	73
PbAc	25	23.68	1	338	25.8	2.5	97	30
PbAc	25	29.71	1	343	22.3	2.5	100	44
PbAc	25	25.86	1	349	28.6	2.7	86	49
PbAc	75	71.55	2	304	58.1	4.25	310	120
PbAc	75	81.04	2	307	46.2	6.5	200	150
PbAc	75	84.25	2	312	67.9	4.75	200	120
PbAc	75	78.61	2	314	40.4	7	160	110
PbAc	75	74.31	2	350	48.2	4.1	320	140
PbAc	225	245.25	3	302	104.2	19.5	540	340
PbAc	225	214.61	3	303	102.4	18	890	370
PbAc	225	226.51	3	322	125.8 b	16.5	700	560 b
PbAc	225	244.91	3	327	99.1	19.5	490	360
PbAc	225	234.34	3	342	104.3	15	1000	Missing
TM1	75	74.00	4	313	34.4	3.75	90	74
TM1	75	78.38	4	328	29.2	3.65	180	110
TM1	75	79.96	4	329	50.2	5.5	130	100
TM1	75	81.93	4	333	55.8	3.95	140	89
TM1	75	71.79	4	348	50.5	21.5 b	140	Missing
TM1	225	238.91	5	317	91.6	14.5	880	370
TM1	225	248.21	5	324	103.4	12.5	860	340
TM1	225	229.97	5	340	67.1	11	470	230
TM1	225	244.68	5	341	124.3	14.5	1100	410
TM1	225	198.39	5	354	108.8	10	610	410
TM1	500	534.79	6	321	152.6	28	1800	950
TM1	500	506.85	6	332	118.2	24	1600	920
TM1	500	475.24	6	335	104.1	17.5 b	1300	530
TM1	500	536.63	6	355	158.4	24	1300	580
TM1	500	511.79	6	363	116.2	28.5	960 b	750
TM2	75	79.95	7	305	49.9	6.5	180	140
TM2	75	74.54	7	306	50.4	4.75	140	84
TM2	75	79.36	7	316	43.6	5.5	150	88
TM2	75	78.01	7	320	43.2	4.6	150	100
TM2	75	73.80	7	347	26.1	2.8	110	43
TM2	225	237.88	8	301	87.0	12.5	400	350
TM2	225	230.40	8	318	93.5	4 b	760	Missing
TM2	225	219.81	8	352	122.8	18.5 b	700	540
TM2	225	236.32	8	356	63.9	11.5	350	220
TM2	225	257.11	8	358	103.8	14.5	600	280
TM2	500	484.95	9	309	138.4	19	1200	580
TM2	500	517.72	9	330	144.7	23	2300 b	1000 b
TM2	500	499.96	9	351	108.2	18	970	540
TM2	500	561.96	9	353	135.7	21.5	890	560
TM2	500	493.10	9	359	138.0	20	1200	640
Control	0	0.00	10	325	10.5	0.25	5	5
Control	0	0.00	10	337	7.5	0.5	10	5
Control	0	0.00	10	360	12.5	0.5	5	5

a *a priori* outlier determinations (none selected in this study)

b Outside 95% Prediction Intervals

c Professional judgement - Response was lower than that seen in next lowest dose group

TABLE A-9 Best Curve Fit Parameters

## BLOOD

PbAc Curve -	Exp
a	9
b	
c	141.9
d	0.0046
R2	0.971

Untreated Curve -	Exp
a	9
b	
c	141.9
d	0.004
R2	0.905

P-treated Curve -	Exp
a	9
b	
c	141.9
d	0.0039
R2	0.931

## BONE

PbAc Curve -	Linear
a	0.75
b	0.071
c	
d	
R2	0.973

Untreated Curve -	Exp
a	0.75
b	0.049
c	
d	
R2	0.981

P-treated Curve -	Linear
a	0.75
b	0.04
c	
d	
R2	0.961

## LIVER

PbAc Curve -	Linear
a	10.9
b	3.01
c	
d	
R2	0.842

Untreated Curve -	Exp
a	10.9
b	2.96
c	
d	
R2	0.935

P-treated Curve -	Linear
a	10.9
b	2.096
c	
d	
R2	0.901

## KIDNEY

PbAc Curve -	Linear
a	9.8
b	1.48
c	
d	
R2	0.979

Untreated Curve -	Exp
a	9.8
b	1.44
c	
d	
R2	0.909

P-treated Curve -	Linear
a	9.8
b	1.16
c	
d	
R2	0.89

## Equations Used

EXP  $Y=a+c*(1-\exp(-d*dose))$ LIN  $Y=a+b*dose$

TABLE A-10 Relative Bioavailability of Lead in Test Materials

Endpoint	Test Material	
	TM1	TM2
Blood	0.87	0.85
Liver	0.98	0.70
Kidney	0.97	0.78
Bone	0.69	0.56

#### Definitions

Plausible Range: RBA(Blood) to mean RBA for Tissues  
 Preferred Range: RBA(Blood) to (RBA(Blood) + RBA(Tissues))/2  
 Suggested Point Est:  $1/2(RBA(Blood) + (RBA(Blood)+RBA(Tissues))/2)$

#### Relative Bioavailability

	TM1		TM2	
Plausible Range	0.87	0.88	0.85	0.68
Preferred Range	0.87	0.88	0.85	0.76
Point Estimate	0.87		0.81	

#### Absolute Bioavailability

	TM1		TM2	
Plausible Range	43%	44%	42%	34%
Preferred Range	43%	44%	42%	38%
Point Estimate	44%		40%	

TABLE A-11 INTRALABORATORY DUPLICATES

RPD = Relative Percent Difference  
 $RPD = 100 * [Orig - Dup] / ((Orig + Dup) / 2)$

\* Non detects evaluated at 1/2 DL

Pig number	group	material administered	dosage	day	matrix	Duplicate Value*	Original Value*	Average	RPD	Avg RPD	
349	1	PbAc	25	0	Blood	0.5	0.5	0.5	0%		
335	6	Site 1	500	0	Blood	0.5	0.5	0.5	0%		
330	9	Site 2	500	0	Blood	0.5	0.5	0.5	0%		
350	2	PbAc	75	1	Blood	2.0	2.0	2.0	0%		
342	3	PbAc	225	1	Blood	2.0	1.0	1.5	-67%		
320	7	Site 2	75	1	Blood	2.0	1.0	1.5	-67%		
358	8	Site 2	225	2	Blood	5.5	5.0	5.3	-10%		
351	9	Site 2	500	2	Blood	3.9	3.9	3.9	0%		
325	10	Control	0	2	Blood	0.5	0.5	0.5	0%		
318	8	Site 2	225	3	Blood	3.9	3.5	3.7	-11%		
337	10	Control	0	3	Blood	1.0	0.5	0.8	-67%		
360	10	Control	0	3	Blood	1.0	0.5	0.8	-67%		
348	4	Site 1	75	5	Blood	2.0	2.2	2.1	10%		
330	9	Site 2	500	5	Blood	8.3	7.9	8.1	-5%		
359	9	Site 2	500	5	Blood	8.0	7.4	7.7	-8%		
322	3	PbAc	225	7	Blood	7.8	8.1	8.0	4%		
320	7	Site 2	75	7	Blood	1.9	2.5	2.2	27%		
351	9	Site 2	500	7	Blood						
307	2	PbAc	75	9	Blood	4.5	3.7	4.1	-20%		
302	3	PbAc	225	9	Blood	8.3	7.8	8.1	-6%		
347	7	Site 2	75	9	Blood	2.2	1.7	2.0	-26%		
349	1	PbAc	25	12	Blood	3.8	2.9	3.4	-27%		
342	3	PbAc	225	12	Blood	12.3	12.0	12.2	-2%		
355	6	Site 1	500	12	Blood	15.2	13.6	14.4	-11%		
332	6	Site 1	500	15	Blood	14.1	14.6	14.4	3%		
305	7	Site 2	75	15	Blood	4.4	5.7	5.1	26%		
309	9	Site 2	500	15	Blood	13.0	13.1	13.1	1%	-12%	BLOOD
305	7	Site 2	75	15	femur	6.0	6.5	6.3	8%		
309	9	Site 2	500	15	femur	20.0	19.0	19.5	-5%		
332	6	Site 1	500	15	femur	23.0	24.0	23.5	4%	2%	FEMUR
321	6	Site 1	500	15	kidney	280.0	950.0	615.0	109%		
340	5	Site 1	225	15	kidney	240.0	230.0	235.0	-4%		
347	7	Site 2	75	15	kidney	52.0	43.0	47.5	-19%	29%	KIDNEY
342	3	PbAc	225	15	liver	750.0	1000.0	875.0	29%		
358	8	Site 2	225	15	liver	560.0	600.0	580.0	7%		
359	9	Site 2	500	15	liver	1400.0	1200.0	1300.0	-15%	7%	LIVER

Values determined to be outliers (Original = 6.5; Duplicate = 28.7)

**TABLE A-12 CDC STANDARDS**

Sample ID	Day	Q	Measured*			Nominal		
			Low Std	Med Std	High Std	Low Std	Med Std	High Std
3.1	0		2.0			1.7	4.8	14.9
3.1	1		2.0			1.7	4.8	14.9
3.1	3		1.0			1.7	4.8	14.9
3.1	5		2.1			1.7	4.8	14.9
3.1	12		2.7			1.7	4.8	14.9
3.2	1			3.9		1.7	4.8	14.9
3.2	2			3.6		1.7	4.8	14.9
3.2	15			3.5		1.7	4.8	14.9
3.3	0				14.0	1.7	4.8	14.9
3.3	2				14.0	1.7	4.8	14.9
3.3	3				14.9	1.7	4.8	14.9
3.3	5				8.2	1.7	4.8	14.9
3.3	7				13.7	1.7	4.8	14.9
3.3	7				13.4	1.7	4.8	14.9
3.3	9				14.7	1.7	4.8	14.9
3.3	9				14.3	1.7	4.8	14.9
3.3	12				14.4	1.7	4.8	14.9
3.3	15				14.1	1.7	4.8	14.9
Avg			2.0	3.7	13.6			

**FIGURE A-1 PbAc Groups by Day**  
**Raw Data**

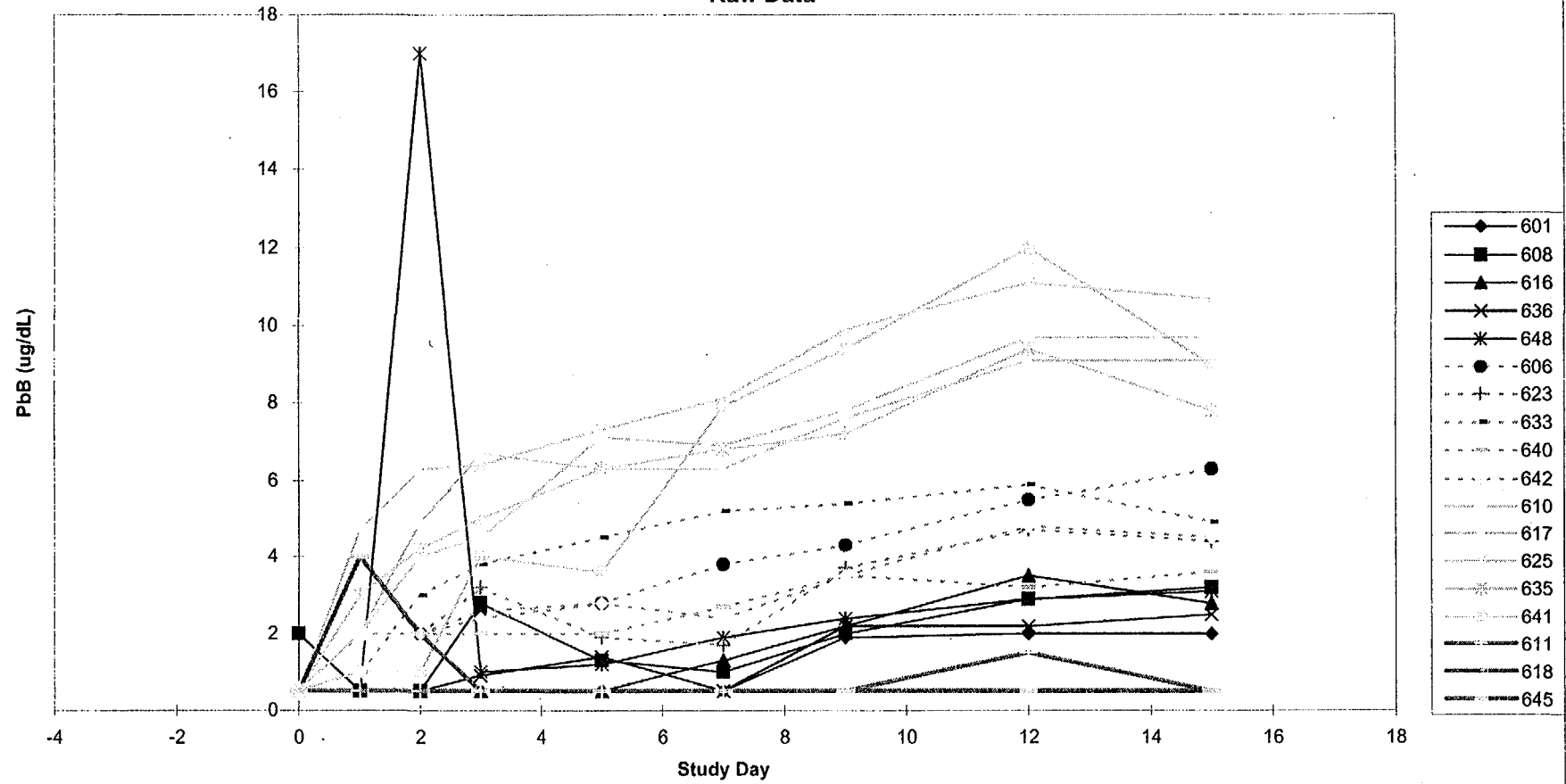
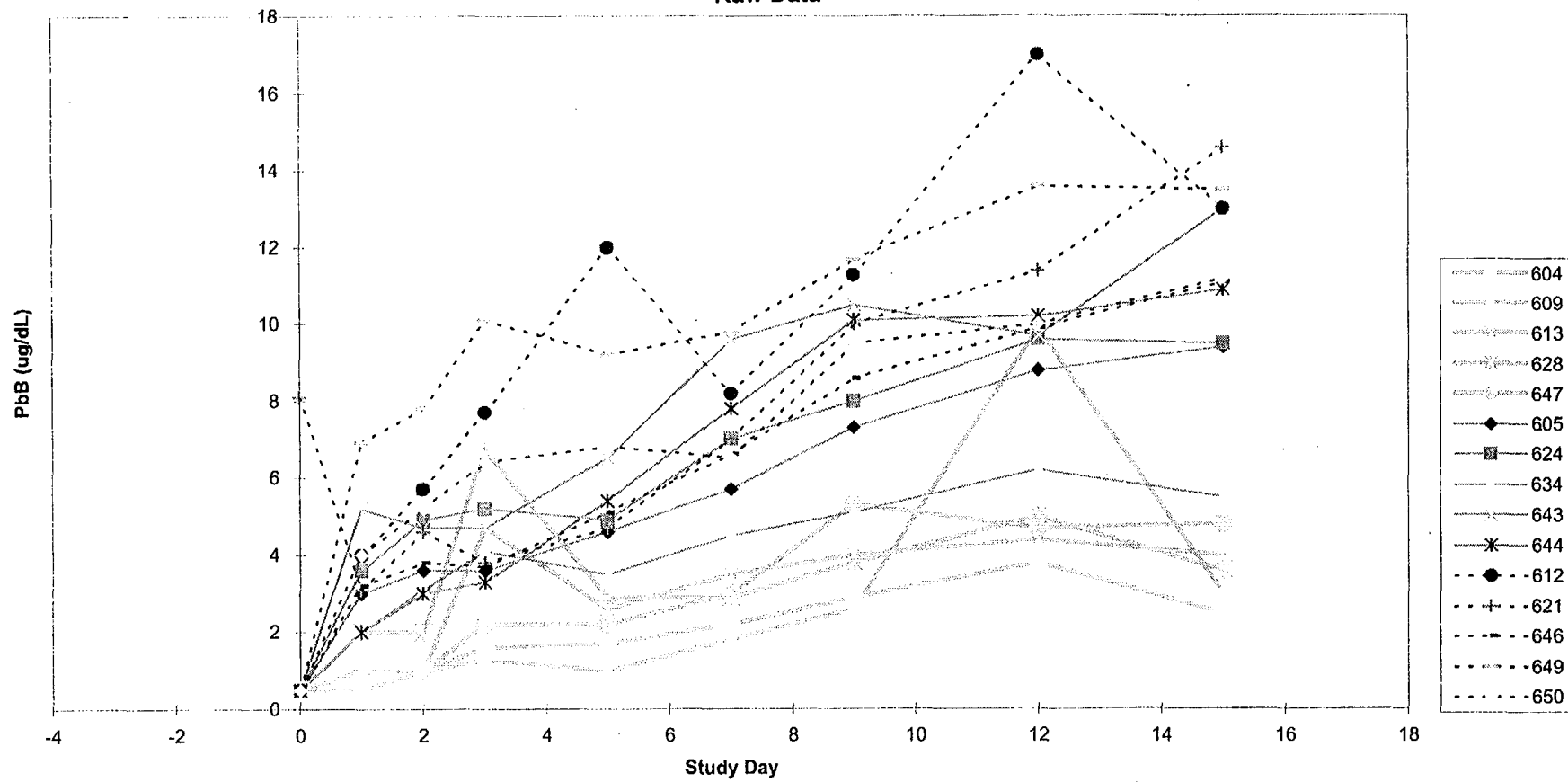


FIGURE A-2 Untreated Groups by Day  
Raw Data



## Raw Data

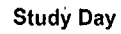
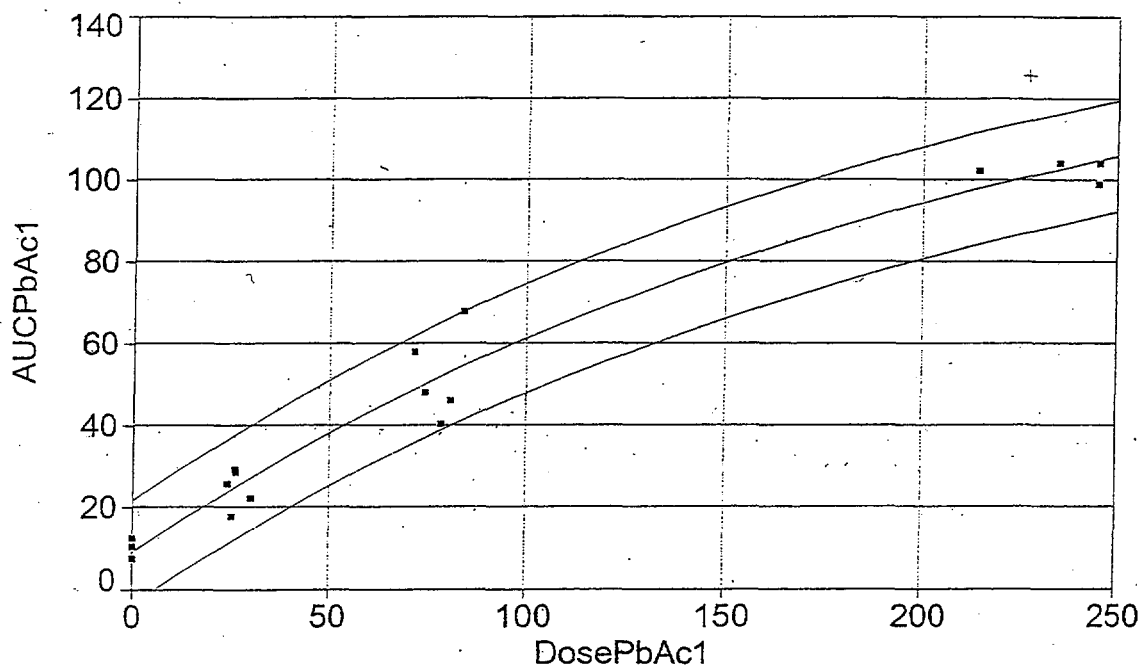


FIGURE A-4 BEST FIT CURVE WITH 95% PREDICTION INTERVALS  
(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

### PbAc - AUC

Rank 2 Eqn 8001 [UDF 1]  $y = \text{AUC}(a)$

$r^2 = 0.971143$  DF Adj  $r^2 = 0.9692192$  FitStdErr=5.9820592 Fstat=538.45812



Rank 2 Eqn 8001 [UDF 1]  $y = \text{AUC}(a)$

$r^2$	Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.9711429962		0.9692191960	5.9820591731	538.45811828

Parm	Value	Std Error	t-value	95% Confidence Limits
a	0.004602252	0.000215463	21.35986735	0.004144553 0.005059950

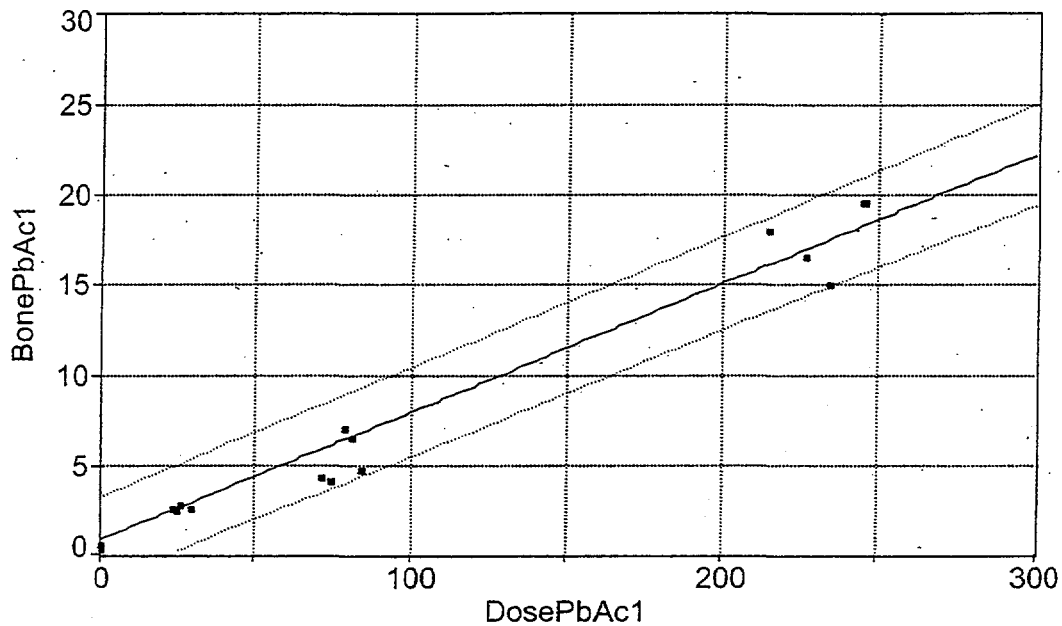
Date	Time	File Source
Jan 9, 2001	3:01:16 PM	CLIPBRD.WK1

FIGURE A-5 - BEST FIT CURVE WITH 95% PREDICTION INTERVALS  
(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

### PbAc - Bone

Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2 = 0.9729649$  DF Adj  $r^2 = 0.9712752$  FitStdErr = 1.1470933 Fstat = 611.81208



Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2$ Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.9729648960	0.9712752020	1.1470933295	611.81208007

Param	Value	Std Error	t-value	95% Confidence Limits
a	0.071267046	0.002185359	32.61113966	0.066650512 0.075883581

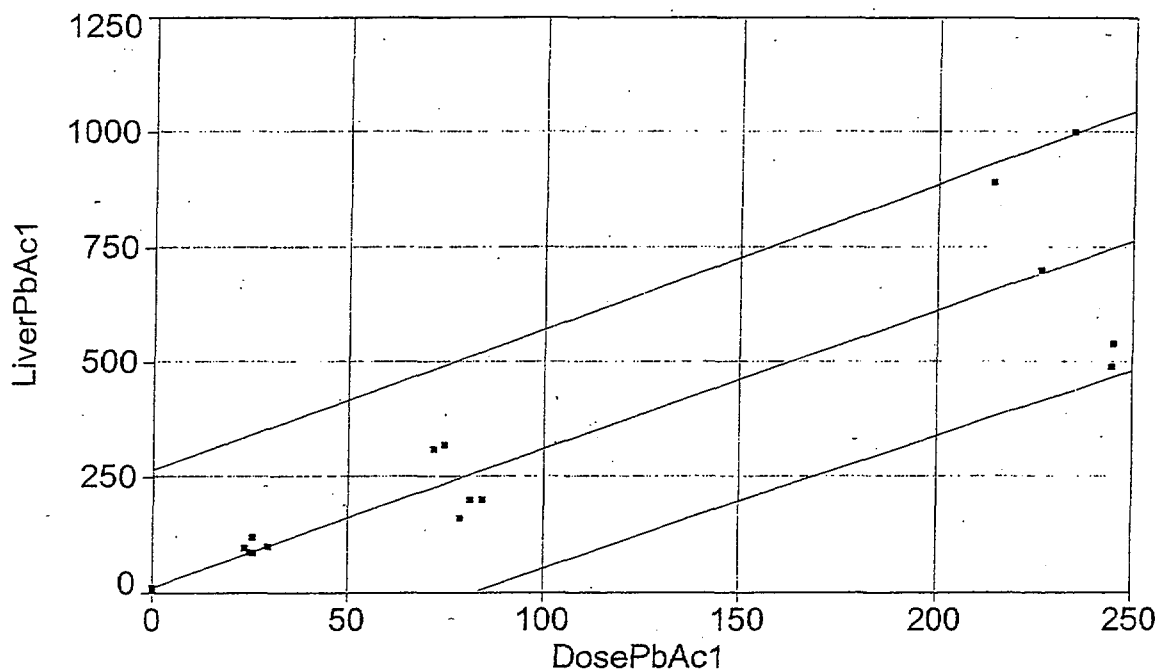
Date	Time	File Source
Feb 9, 2001	12:58:45 PM	CLIPBRD.WK1

FIGURE A-6 BEST FIT CURVE WITH 95% PREDICTION INTERVALS  
(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

**PbAc - Liver**

Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2 = 0.84202407$  DF Adj  $r^2 = 0.83215058$  FitStdErr=120.78928 Fstat=90.611333



Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2$ Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.8420240733	0.8321505779	120.78927910	90.611332677

Parm	Value	Std Error	t-value	95% Confidence Limits
a	3.011262498	0.230118969	13.08567700	2.525140049 3.497384948

Date	Time	File Source
Jan 15, 2001	9:58:31 AM	CLIPBRD.WK1

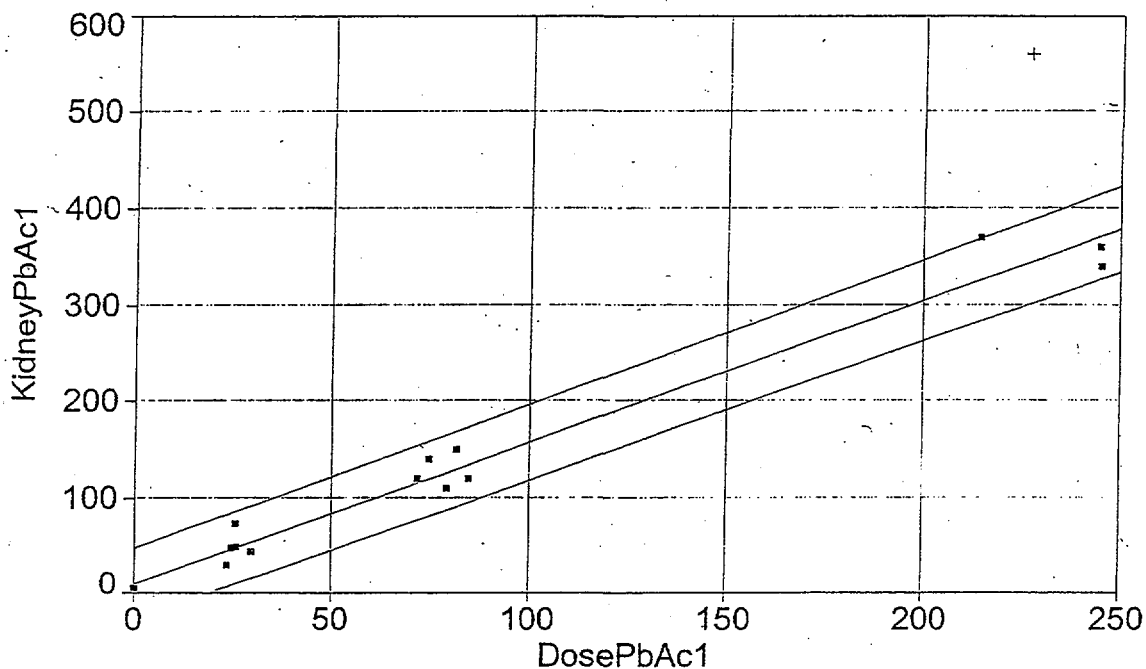
FIGURE A-7 BEST FIT CURVE WITH 95% PREDICTION INTERVALS

(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

### PbAc – Kidney

Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2 = 0.97924659$  DF Adj  $r^2 = 0.9777642$  FitStdErr=17.898238 Fstat=707.77282



Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2$ Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.9792465910	0.9777642047	17.898237950	707.77282388

Parm	Value	Std Error	t-value	95% Confidence Limits
a	1.475620344	0.042454579	34.75762545	1.385388352 1.565852335

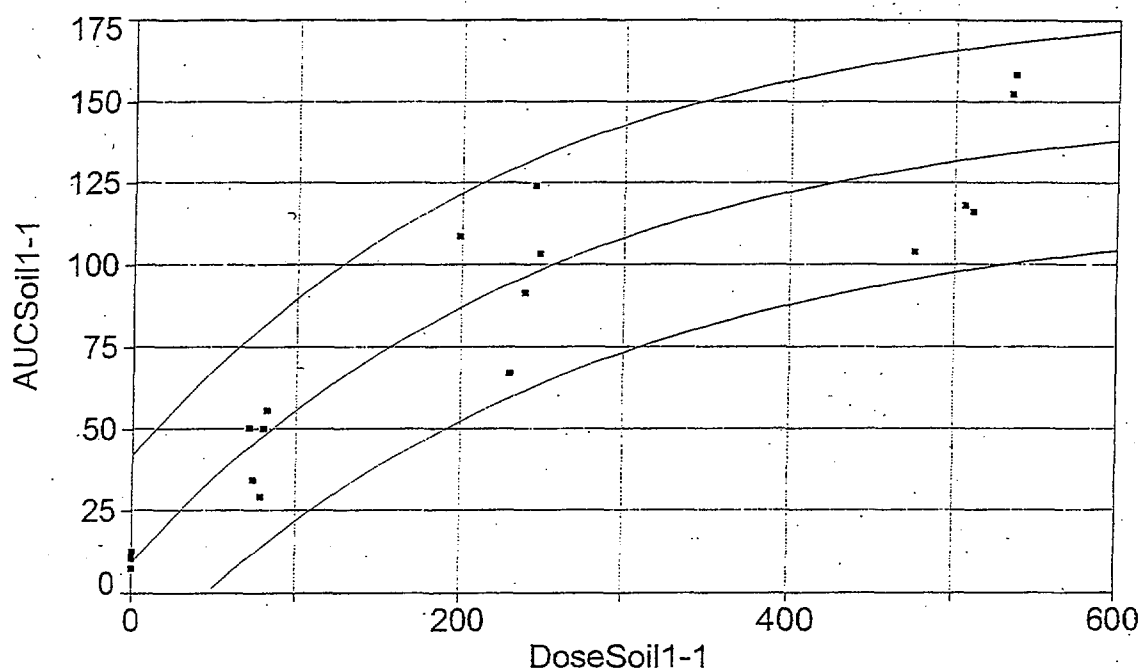
Date	Time	File Source
Jan 15, 2001	10:00:26 AM	CLIPBRD.WK1

FIGURE A-8 BEST FIT CURVE WITH 95% PREDICTION INTERVALS  
(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

TM#1 - AUC

Rank 1 Eqn 8009 [UDF 2]  $y = \text{AUC NC}(a)$

$r^2 = 0.90451184$  DF Adj  $r^2 = 0.89854383$  FitStdErr=15.595457 Fstat=161.03255



Rank 1 Eqn 8009 [UDF 2]  $y = \text{AUC NC}(a)$

$r^2$	Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.9045118438		0.8985438341	15.595456570	161.03255068

Parm	Value	Std Error	t-value	95% Confidence Limits
a	0.004003848	0.000411061	9.740274613	0.003135488 0.004872208

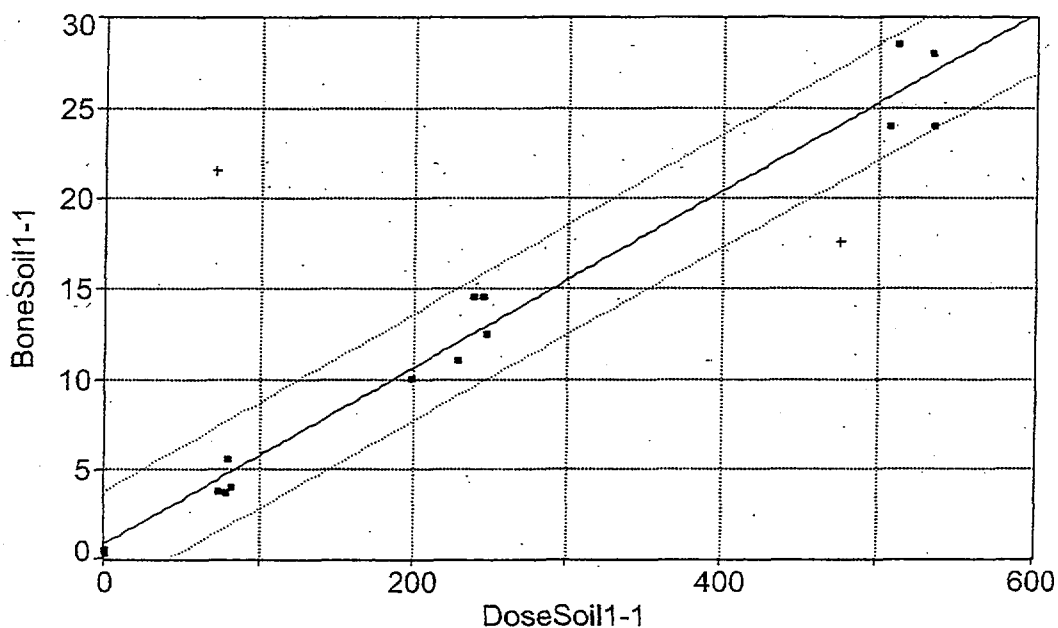
Date	Time	File Source
Jan 9, 2001	3:01:41 PM	CLIPBRD.WK1

FIGURE A-9 BEST FIT CURVE WITH 95% PREDICTION INTERVALS  
(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

TM#1 - Bone

Rank 1 Eqn 8017 [UDF 3] y=LINFORCE(a)

$r^2=0.98120086$  DF Adj  $r^2=0.97985807$  FitStdErr=1.3760025 Fstat=782.90896



Rank 1 Eqn 8017 [UDF 3] y=LINFORCE(a)

$r^2$ Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.9812008628	0.9798580673	1.3760025073	782.90895873

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.048897266	0.001238993	39.46533933	0.046263939	0.051530592

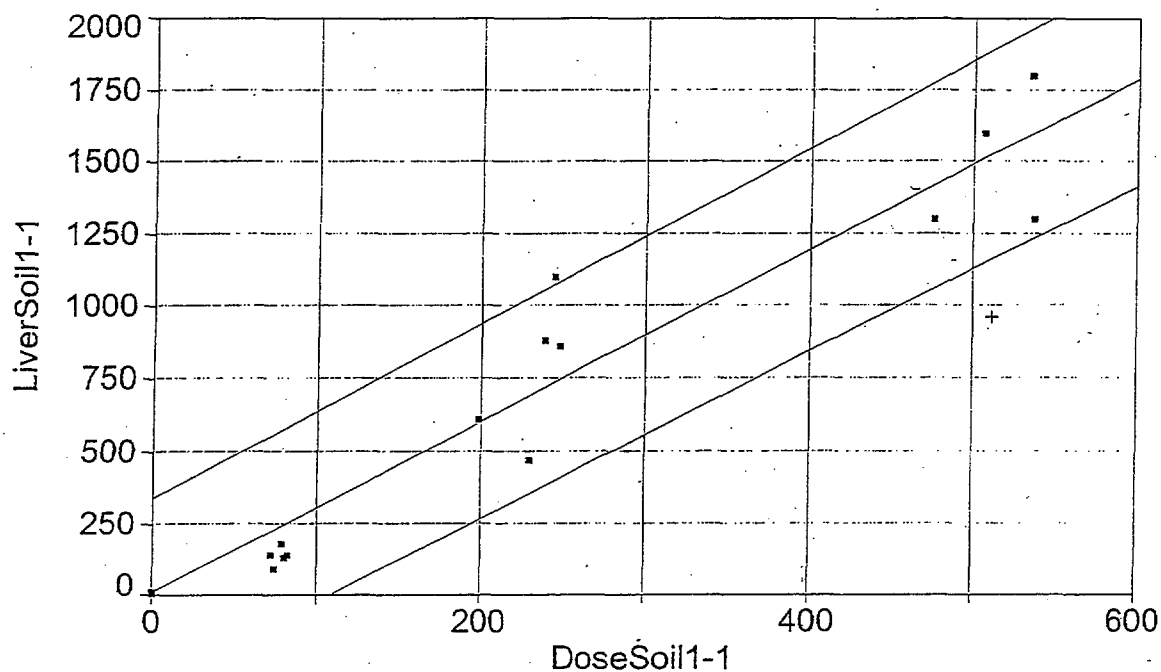
Date	Time	File Source
Feb 9, 2001	1:00:34 PM	CLIPBRD.WK1

FIGURE A-10 BEST FIT CURVE WITH 95% PREDICTION INTERVALS  
(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

**TM#1 - Liver**

Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2 = 0.93488562$  DF Adj  $r^2 = 0.93054466$  FitStdErr=155.52173 Fstat=229.72145



Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2$ Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.9348856184	0.9305446597	155.52173092	229.72144606

Parm	Value	Std Error	t-value	95% Confidence Limits
a	2.964784622	0.141156976	21.00345800	2.664930509 3.264638735

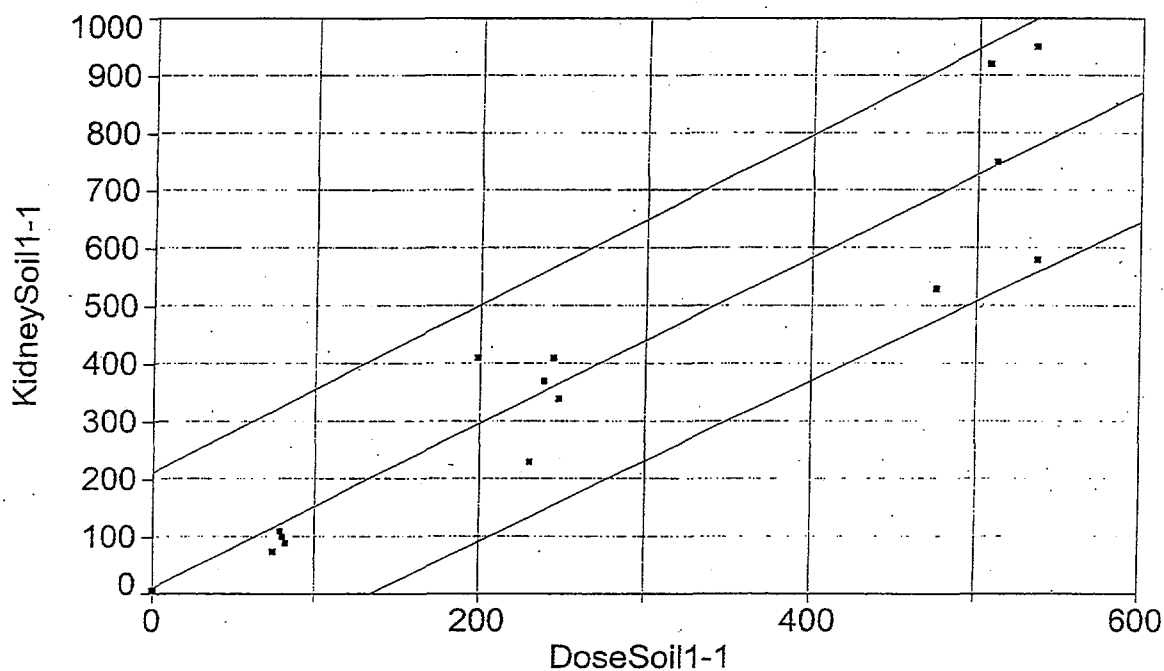
Date	Time	File Source
Jan 15, 2001	9:59:06 AM	CLIPBRD.WK1

FIGURE A-11 BEST FIT CURVE WITH 95% PREDICTION INTERVALS  
(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

**TM#1 – Kidney**

Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2 = 0.90891658$  DF Adj  $r^2 = 0.90284435$  FitStdErr = 95.251142 Fstat = 159.66314



Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2$	Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.9089165776		0.9028443495	95.251142383	159.66314030

Parm	Value	Std Error	t-value	95% Confidence Limits
a	1.436303152	0.079279311	18.11699849	1.267893286 1.604713017

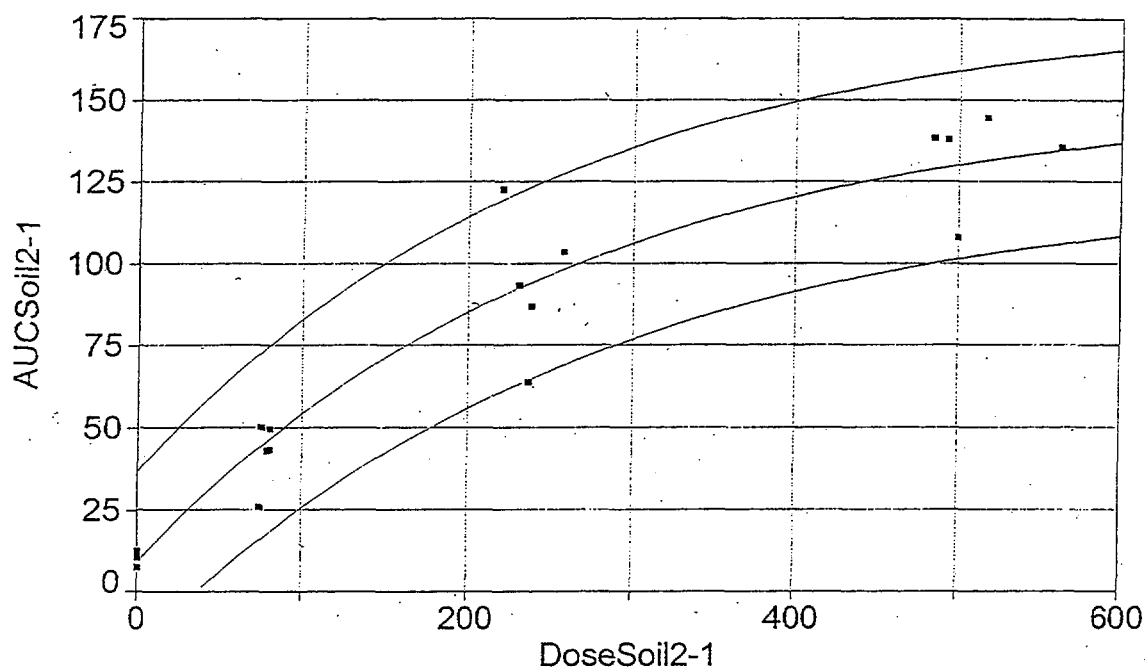
Date	Time	File Source
Jan 15, 2001	10:00:51 AM	CLIPBRD.WK1

FIGURE A-12 BEST FIT CURVE WITH 95% PREDICTION INTERVALS  
(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

TM#2 - AUC

Rank 1 Eqn 8009 [UDF 2]  $y = \text{AUC NC}(a)$

$r^2 = 0.93103012$  DF Adj  $r^2 = 0.9267195$  FitStdErr=13.17285 Fstat=229.48439



Rank 1 Eqn 8009 [UDF 2]  $y = \text{AUC NC}(a)$

$r^2$ Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.9310301163	0.9267194985	13.172849831	229.48439407

Parm	Value	Std Error	t-value	95% Confidence Limits
a	0.003858687	0.000332455	11.60663730	0.003156381 0.004560993

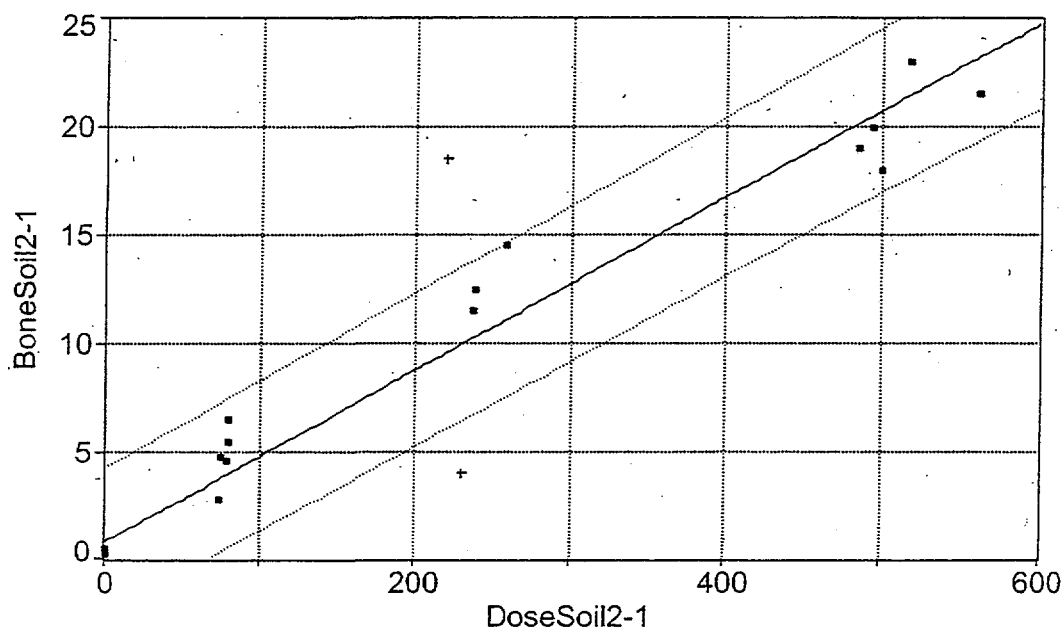
Date	Time	File Source
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FIGURE A-13 BEST FIT CURVE WITH 95% PREDICTION INTERVALS  
(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

**TM#2 – Bone**

Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2 = 0.96128686$  DF Adj  $r^2 = 0.95852163$  FitStdErr = 1.6347754 Fstat = 372.4653



Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2$ Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.9612868555	0.9585216309	1.6347754208	372.46529658

Parm	Value	Std Error	t-value	95% Confidence Limits
a	0.039859551	0.001406598	28.33755021	0.036869999 0.042849103

Date	Time	File Source
Feb 9, 2001	1:01:55 PM	CLIPBRD.WK1

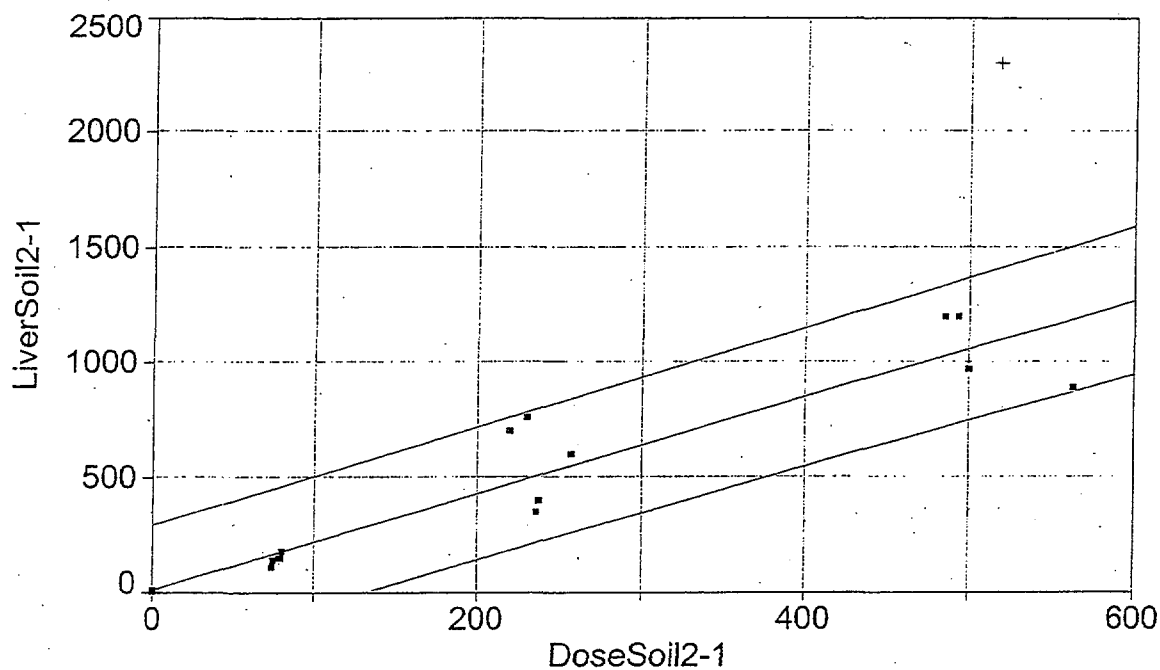
FIGURE A-14 BEST FIT CURVE WITH 95% PREDICTION INTERVALS

(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

TM#2 - Liver

Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2 = 0.90065167$  DF Adj  $r^2 = 0.89402845$  FitStdErr=133.39454 Fstat=145.04951



Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2$	Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.9006516700		0.8940284480	133.39453976	145.04951135

Parm	Value	Std Error	t-value	95% Confidence Limits
a	2.095646700	0.121234398	17.28590847	1.838113323 2.353180076

Date	Time	File Source
Jan 15, 2001	9:59:40 AM	CLIPBRD.WK1

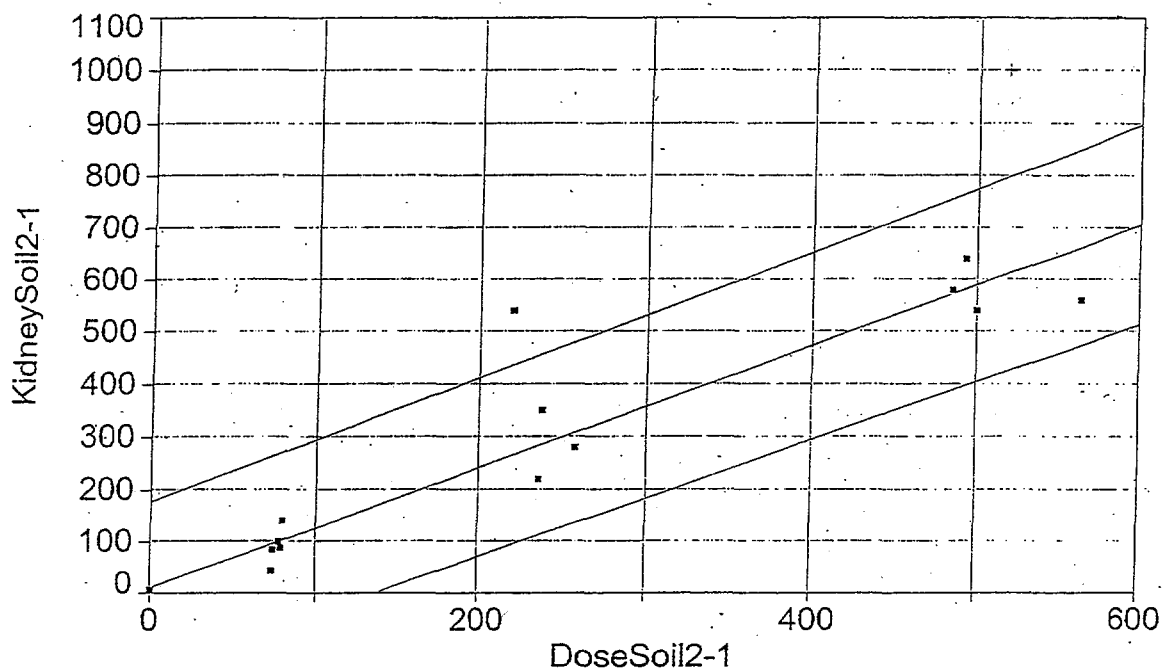
FIGURE A-15. BEST FIT CURVE WITH 95% PREDICTION INTERVALS

(generated using Table Curve 2D v. 3.0. Outliers represented by "+")

**TM#2 - Kidney**

Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2 = 0.89039679$  DF Adj  $r^2 = 0.88256799$  FitStdErr=79.091465 Fstat=121.85731



Rank 1 Eqn 8017 [UDF 3]  $y = \text{LINFORCE}(a)$

$r^2$ Coef Det	DF Adj $r^2$	Fit Std Err	F-value
0.8903967929	0.8825679924	79.091465332	121.85730922

Parm	Value	Std Error	t-value	95% Confidence Limits
a	1.160730634	0.073575623	15.77602182	1.004354686 1.317106581

Date	Time	File Source
Jan 15, 2001	10:01:29 AM	CLIPBRD.WK1

APPENDIX B

WASHINGTON GROUP MEMORANDUM



## Technical Memorandum

**To:** Bonnie Lavelle  
**From:** Kevin Williamson  
**REF:** RAC No. 68-W7-0039, WA. No. 004-RICO-089R  
**Subject:** VB/I-70 Bio-Availability Soil Sample Preparation  
**Cc:** M. Green, B. Meyers, T. Hammonds

In support of the Vasquez Blvd./ I-70 (VB/I-70) risk assessment program, Washington Group International (WGI) was tasked with preparing soil samples for a Bio-Availability study to be performed by EPA Region VIII toxicologists. Soil samples from various residential properties were selected that represent specific concentrations of lead, and arsenic. These soil samples were collected during Phase IIIA and Phase IIIB of the remedial investigation within the neighborhoods of Swansca, Elyria, Cole, Clayton, and the southwest portion of Globeville. Bonnie Lavelle (EPA) instructed WGI to prepare two soil samples for this study representing the Western and Eastern neighborhoods. Soil samples were selected based on previously determined lead (Pb) and arsenic (As) concentrations, as determined using an EDXRF Quanx, and composited in accordance with the attached procedure (Attachment 1). On October 19, 2000 twelve soil samples were selected for the East sample, and eight soil samples were selected for the West sample. Based on remaining sample weights and previously measured concentrations, six soil samples were combined to make the East sample, and five soil samples were combined to make the West sample. The following sample IDs were used to make the East sample: 3-03583-B, 3-03588-B, 3-02387-B, 3-08444-B, 3-08978-B, and 3-08979-B. Upon composite of those samples the East sample was designated 3-15621-B. The following sample IDs were used to make the West sample: 3-10740-B, 3-10318-B, 3-03910-B, 3-10734-B, and 3-10319. Upon composite of those samples the West sample was designated 3-15628-B.

On October 20, 2000, soil samples were dried in a laboratory oven at 105 C, bulk sieved with a 2-mm screen, and fine sieved with a 250-µm screen. Bulk and fine fraction samples were split for EDXRF, and TAL metals analysis via Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP) analysis. Two bio-availability test substances were produced consisting of 1.2 and 1.6 kilograms of the fine fraction composite soils. Test substance samples were relinquished under chain of custody to Syracuse Research Center (SRC).

All arsenic and lead soil sample results and corresponding quality control sample results are summarized in the attached tables. Table 1 displays initial XRF screening results to insure study mandated concentration levels. Table 2 displays the bulk and fine sieved fractions also analyzed using XRF. Table 3 displays off-site laboratory

ICP results, with laboratory data sheets included as Attachment 2. Analytical results indicate that the average lead concentrations of the East test substance are 723 mg/kg (ICP) and 788 mg/kg (XRF). Average lead concentrations for the West test substance are 1050 mg/kg (ICP) and 987 mg/kg (XRF). Intra-sample variability is low with the exception of the bulk fraction ICP results.

Table 1

Location	Fraction	Sample ID	Parent Sample ID	Results (mg/Kg)		ICP Results (mg/Kg)		Date/Time Analyzed
				Arsenic	Lead	Arsenic	Lead	
West	Bulk (Screen)	3-15628-B	3-15628-B	30	908			10/19/2000 @ 1207
West	Bulk (Screen)	3-15628-B	3-15628-B	23	764			10/19/2000 @ 1207
West	Bulk (Screen)	3-15628-B	3-15628-B	30	823			10/19/2000 @ 1207
			Average	28	832			
East	Bulk (Screen)	3-15621-B	3-15621-B	27	639			10/19/2000 @ 1207
East	Bulk (Screen)	3-15621-B	3-15621-B	10	658			10/19/2000 @ 1207
			Average	19	649			
		NIST2711		88	1150			10/19/2000 @ 1207

Table 2

Location	Fraction	Sample ID	Parent Sample	Results (mg/Kg)		ICP Results (mg/Kg)		Date/Time Analyzed
				Arsenic	Lead	Arsenic	Lead	
West	Bulk	3-15628-B1	3-15628-B	30	983			10/19/2000 @ 1851
West	Bulk	3-15628-B2	3-15628-B	22	1001			10/19/2000 @ 1851
West	Bulk	3-15628-B3	3-15628-B	31	1038			10/19/2000 @ 1851
West	Bulk	3-15628-B4	3-15628-B	13	978			10/19/2000 @ 1851
West	Bulk	3-15628-B5	3-15628-B	46	960			10/19/2000 @ 1851
West	Bulk	3-15628-B6	3-15628-B	26	898			10/19/2000 @ 1851
West	Bulk	3-15628-B7	3-15628-B	22	998			10/19/2000 @ 1851
West	Bulk	3-15628-B8	3-15628-B	31	1001			10/19/2000 @ 1851
West	Bulk	3-15628-B9	3-15628-B	25	857			10/19/2000 @ 1851
			<b>Average</b>	<b>27</b>	<b>968</b>			
West	Fine	3-15628-F1	3-15628-F	35	1062			10/19/2000 @ 1851
West	Fine	3-15628-F2	3-15628-F	27	1008			10/19/2000 @ 1851
West	Fine	3-15628-F3	3-15628-F	27	1059			10/19/2000 @ 1851
West	Fine	3-15628-F4	3-15628-F	19	1052			10/19/2000 @ 1851
West	Fine	3-15628-F5	3-15628-F	32	1078			10/19/2000 @ 1851
West	Fine	3-15628-F6	3-15628-F	41	1095			10/19/2000 @ 1851
West	Fine	3-15628-F7	3-15628-F	22	1008			10/19/2000 @ 1851
West	Fine	3-15628-F8	3-15628-F	17	1022			10/19/2000 @ 1851
West	Fine	3-15628-F9	3-15628-F	23	1062			10/19/2000 @ 1851
			<b>Average</b>	<b>27</b>	<b>1050</b>			
		NIST2711		99	1169			10/19/2000 @ 1851
East	Bulk	3-15621-B1	3-15621-B	30	722			10/19/2000 @ 1549
East	Bulk	3-15621-B2	3-15621-B	26	721			10/19/2000 @ 1549
East	Bulk	3-15621-B3	3-15621-B	26	685			10/19/2000 @ 1549
East	Bulk	3-15621-B4	3-15621-B	24	746			10/19/2000 @ 1549
East	Bulk	3-15621-B5	3-15621-B	25	746			10/19/2000 @ 1549
East	Bulk	3-15621-B6	3-15621-B	21	764			10/19/2000 @ 1549
East	Bulk	3-15621-B7	3-15621-B	27	840			10/19/2000 @ 1549
East	Bulk	3-15621-B8	3-15621-B	29	702			10/19/2000 @ 1549
East	Bulk	3-15621-B9	3-15621-B	10	694			10/19/2000 @ 1549
			<b>Average</b>	<b>24</b>	<b>736</b>			
East	Fine	3-15621-F1	3-15621-F	9	839			10/19/2000 @ 1549
East	Fine	3-15621-F2	3-15621-F	17	780			10/19/2000 @ 1549
East	Fine	3-15621-F3	3-15621-F	14	774			10/19/2000 @ 1549
East	Fine	3-15621-F4	3-15621-F	18	765			10/19/2000 @ 1549
East	Fine	3-15621-F5	3-15621-F	17	770			10/19/2000 @ 1549
East	Fine	3-15621-F6	3-15621-F	16	750			10/19/2000 @ 1549
East	Fine	3-15621-F7	3-15621-F	33	827			10/19/2000 @ 1549
East	Fine	3-15621-F8	3-15621-F	22	804			10/19/2000 @ 1549
East	Fine	3-15621-F9	3-15621-F	16	787			10/19/2000 @ 1549
			<b>Average</b>	<b>18</b>	<b>788</b>			
		NIST2711		96	1168			10/19/2000 @ 1549

Table 3

Location	Fraction	Sample ID	Parent Sample	Results (mg/Kg)		ICP Results (mg/Kg)		Date/Time Analyzed
				Arsenic	Lead	Arsenic	Lead	
West	Bulk	3-15703-B	3-15628-B			10	900	10/23/00
West	Bulk	3-15704-B	3-15628-B			9	370	10/23/00
West	Bulk	3-15705-B	3-15628-B			10	400	10/23/00
					<b>Average</b>	<b>10</b>	<b>557</b>	
West	Fine	3-15700-F	3-15628-F			26	970	10/23/00
West	Fine	3-15701-F	3-15628-F			25	1000	10/23/00
West	Fine	3-15702-F	3-15628-F			24	990	10/23/00
					<b>Average</b>	<b>25</b>	<b>987</b>	
East	Bulk	3-15622-B	3-15621-B			10	610	10/23/00
East	Bulk	3-15623-B	3-15621-B			9	1100	10/23/00
East	Bulk	3-15624-B	3-15621-B			10	620	10/23/00
					<b>Average</b>	<b>10</b>	<b>777</b>	
East	Fine	3-15627-F	3-15621-F			19	700	10/23/00
East	Fine	3-15629-F	3-15621-F			19	710	10/23/00
East	Fine	3-15630-F	3-15621-F			20	760	10/23/00
					<b>Average</b>	<b>19</b>	<b>723</b>	

**ATTACHMENT 1**

**BIO-AVAILABILITY SAMPLE PREPARATION PROCEDURE**

BIO-AVAILABILITY SOIL SAMPLE PREPARATION PROCEDURE  
OCTOBER 2000

RE: RAC No. 68-W7-0039, WA No. 004-RICO-089R (VB/I-70 OU1)

**OBJECTIVES:**

1. Produce two fine sieved, composite soil samples for use EPA's use in a pig study containing relatively high levels of lead and low levels of arsenic. If possible, one sample should be representative of COLE (and FIVE POINTS) neighborhood soils and one representative of CLAYTON (and SWANSEA) soils.
2. Measure concentrations and variability of both the fine fraction and bulk fraction of the composite using both XRF and ICP.

**CONTACTS:**

Bonnie Lavelle  
303/312-6579, 303/898-8465

Chris Weis  
303/312-6671, 720/320-6254 (cell), 800/759-8888 #1083306 (pager)

Tracy Hammond, SRC  
303/713-9549

**PROCEDURE**

**I. Identify Samples for Compositing**

1. Evaluate list of candidate samples and minimum quantity provided by Tracy along with neighborhood data. Group by 2 neighborhoods WEST and EAST (and other - may not want to include Globeville or Elyria for this study). Calculate average concentration - consult Bonnie if concentration is too low based on Tracy's mass requirements (target 1100-1200 ppm lead); or eliminate samples from consideration that bring the average down.
2. Note that mass of each composite needed is for Test Substance per Tracy's table, PLUS 50 grams, plus 18 XRF samples, plus 6 ICP samples, and plus some if possible for archive.
3. Retrieve samples from archive for each group.
4. Weigh raw samples; Re-evaluate relative contribution (composite design) of samples (maximize volume of higher Pb concentration samples) in order to achieve target/high Pb concentration in composite. If mass is inadequate to generate WEST and EAST composites, consult EPA for guidance on alternative approach targeting 2 different concentration levels.

**II. Prepare Composite**

1. Weigh out portions/all of the raw samples per composite design and composite into the two Raw samples. Label each uniquely 3-XXXXX-R. Homogenize very well.

2. Thoroughly dry each raw sample. Bulk sieve each entire composite; Label with sample IDs (-B).
3. Prep one XRF cup for each -B and screen by XRF - confirm adequate sample mass for each composite. If mass is low, dry and bulk sieve additional soil (from appropriate EAST or WEST group), re-homogenize, and re-screen -B.
4. Reserve -B sample quantities adequate for 9 XRF samples and 3 ICP samples.
5. Fine sieve (60 mesh) remaining -B sample mass to produce the two composite -F samples.

### III. Split Samples - Bulk

1. Split each -B composite into 3 uniquely identified samples and ship for ICP analysis of all EPA Target Analyte List metals (std or 48-hour turnaround \*\*BONNIE: may be easier to submit all for quick turnaround to enable completion of this task next week, rather than get a separate data package in 3+ weeks).
2. Grind / cup 9 aliquots (original sample ID 3-XXXXXX-B1 --> B9 \*\*\* BONNIE: does this have to be blind to the XRF analyst? If so, assign unique sample IDs) for XRF analysis

### IV. Split Samples - Fine

1. Split each -F composite into 3 uniquely identified samples and ship for ICP analysis of all EPA Target Analyte List metals (48-hour turnaround)
2. Grind / cup 9 aliquots for each (original sample ID 3-XXXXXX-F1 --> F9 \*\*\* BONNIE: does this have to be blind to the XRF analyst? If so, assign unique sample IDs) for XRF analysis
3. Split each remaining -F composite into a 50-gram sample (for physical testing), a required mass of Test Substance, and any remaining quantity for archive; ALL with same original -F sample ID.
4. Transfer Sample consisting of 50-gram and Test Substance portions to Tracy Hammond (phone her for a pick-up) under COC.

### VI. XRF Analysis / Reporting

1. Analyze 9 - B and 9 -F samples from each composite together along with NIST standard and blank.

### VII. Documentation

1. Produce a Technical Memorandum summarizing task, include: prep log/XRF instrument log/COCs/ICP data received; three copies to Bonnie.
2. FAX ICP data to Bonnie, Chris and Tracy upon receipt.

BIO-AVAILABILITY SOIL SAMPLE PREPARATION PROCEDURE  
OCTOBER 2000

RE: RAC No. 68-W7-0039, WA No. 004-RICO-089R (VB/I-70 OUI)

**OBJECTIVES:**

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5. Fine sieve (60 mesh) remaining -B sample mass to produce the two composite -F samples.

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1. Split each -B composite into 3 uniquely identified samples and ship for ICP analysis of all EPA Target Analyte List metals (std or 48-hour turnaround \*\*BONNIE: may be easier to submit all for quick turnaround to enable completion of this task next week, rather than get a separate data package in 3+ weeks).
2. Grind / cup 9 aliquots (original sample ID 3-XXXXXX-B1 --> B9 \*\*\* BONNIE: does this have to be blind to the XRF analyst? If so, assign unique sample IDs) for XRF analysis

### IV. Split Samples - Fine

1. Split each -F composite into 3 uniquely identified samples and ship for ICP analysis of all EPA Target Analyte List metals (48-hour turnaround)
2. Grind / cup 9 aliquots for each (original sample ID 3-XXXXXX-F1 --> F9 \*\*\* BONNIE: does this have to be blind to the XRF analyst? If so, assign unique sample IDs) for XRF analysis
3. Split each remaining -F composite into a 50-gram sample (for physical testing), a required mass of Test Substance, and any remaining quantity for archive; ALL with same original -F sample ID.
4. Transfer Sample consisting of 50-gram and Test Substance portions to Tracy Hammond (phone her for a pick-up) under COC.

### VI. XRF Analysis / Reporting

1. Analyze 9 - B and 9 -F samples from each composite together along with NIST standard and blank.

### VII. Documentation

1. Produce a Technical Memorandum summarizing task, include: prep log/XRF instrument log/COCs/ICP data received; three copies to Bonnie.
2. FAX ICP data to Bonnie, Chris and Tracy upon receipt.

**ATTACHMENT 2**

**LABORATORY DATA SHEETS FOR  
TARGET ANALYTE LIST METALS BY ICP**

# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.  
Work Order Number: 0010156

Client Name: Morrison Knudsen Corporation

Client/Project ID: VB/I-70 IIB 4994

Field ID: 3-15622-B  
Lab ID: 0010156-1

Sample Matrix: SOIL  
% Moisture: 0.2  
Date Collected: 19-Oct-00  
Date Extracted: 23-Oct-00  
Date Analyzed: 23-Oct-00

Prep Batch: IP001023-1  
QC Batch ID: IP001023-1-1  
Run ID: IT001023-1A4  
Cleanup: NONE  
Basis: Dry Weight

Sample Aliquot: 1 G  
Final Volume: 100 ML  
Result Units: MG/KG

File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7429-00-5	ALUMINUM	1	2900	20	0.69		
7440-38-0	ANTIMONY	1	1.8	2	0.26	B	
7440-38-2	ARSENIC	1	9.6	1	0.28		
7440-39-3	BARIUM	1	130	10	0.018		
7440-11-7	BERYLLIUM	1	0.33	0.5	0.015	B	
7440-43-9	CADMIUM	1	1.8	0.5	0.017		
7440-70-2	CALCIUM	1	3400	100	0.54		
7440-47-3	CHROMIUM	1	15	1	0.047		
7440-48-4	COBALT	1	3.1	1	0.05		
7440-50-8	COPPER	1	35	1	0.032		
7439-89-6	IRON	1	16000	10	0.8		
7439-92-1	LEAD	1	610	0.3	0.14		
7439-95-4	MAGNESIUM	1	1100	100	0.79		
7439-98-5	MANGANESE	1	250	1	0.025		
7440-02-0	NICKEL	1	0.5	2	0.078		
7440-09-7	POTASSIUM	1	840	100	5.3		
7762-49-2	SELENIUM	1	1	0.5	0.27		
7440-22-4	SILVER	1	1	1	0.063	U	
7440-23-5	SODIUM	1	140	100	0.25		
7440-28-0	TITANIUM	1	1	1	0.39	U	
7440-62-2	VANADIUM	1	9.9	1	0.033		
7440-66-6	ZINC	1	300	2	0.29		

Data Package ID: IT0010156-1

Date Printed: Tuesday, October 24, 2000

Paragon Analytics Inc.

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LIMS Version: 1.002

# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.

Work Order Number: 0010156

Client Name: Morrison Knudsen Corporation

ClientProject ID: VBA-70 NIB 4994

Field ID: 3-15623-B  
Lab ID: 0010156-2

Sample Matrix: SOIL

% Moisture: 0.2

Date Collected: 19-Oct-00

Date Extracted: 23-Oct-00

Date Analyzed: 23-Oct-00

Prep Batch: IP001023-1

QC Batch ID: IP001023-1-1

Run ID: IT001023-1A4

Cleanup: NONE

Basis: Dry Weight

Sample Aliquot: 1 G

Final Volume: 100 ML

Result Units: MG/KG

File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7429-90-5	ALUMINUM	1	2500	20	0.69		
7440-38-0	ANTIMONY	1	1.2	2	0.26	B	
7440-38-2	ARSENIC	1	8.7	1	0.28		
7440-39-3	BARIUM	1	260	10	0.018		
7440-41-7	BERYLLIUM	1	0.28	0.5	0.015	B	
7440-43-9	CADMIUM	1	2.2	0.5	0.017		
7440-70-2	CALCIUM	1	4000	100	0.54		
7440-47-3	CHROMIUM	1	7.1	1	0.047		
7440-48-4	COBALT	1	2.6	1	0.05		
7440-50-8	COPPER	1	24	1	0.032		
7439-89-6	IRON	1	10000	10	0.8		
7439-92-1	LEAD	10	1100	3	1.4		
7439-95-4	MAGNESIUM	1	1200	100	0.79		
7439-96-5	MANGANESE	1	260	1	0.025		
7440-02-0	NICKEL	1	4.5	2	0.078		
7440-09-7	POTASSIUM	1	780	100	5.3		
7782-49-2	SELENIUM	1	0.68	0.5	0.27		
7440-22-1	SILVER	1	0.32	1	0.063	B	
7440-23-5	SODIUM	1	140	100	0.25		
7440-28-0	THALLIUM	1	1	1	0.39	U	
7440-62-2	VANADIUM	1	9.8	1	0.033		
7440-66-6	ZINC	1	540	2	0.29		

Data Package ID: IT0010156-1

Date Printed: Tuesday, October 21, 2000

Paragon Analytics Inc.

LIMS Version 1.002

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# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.

Work Order Number: 0010156

Client Name: Morrison Knudsen Corporation

Client/Project ID: VB/I-70 IIB 4994

Flight ID: 3-15624-B  
Lab ID: 0010156-3

Sample Matrix: SOIL  
% Moisture: 0.5  
Date Collected: 19-Oct-00  
Date Extracted: 23-Oct-00  
Date Analyzed: 23-Oct-00

Prep Batch: IP001023-1  
QC Batch ID: IP001023-1-1  
Run ID: IT001023-1A4  
Cleanup: NONE  
Basis: Dry Weight

Sample Aliquot: 1 G  
Final Volume: 100 ML  
Result Units: MG/KG  
File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7439-90-6	ALUMINUM	1	2800	20	0.69		
7440-38-0	ANTIMONY	1	0.67	2	0.27	B	
7440-30-2	ARSENIC	1	9.5	1	0.28		
7440-39-3	BARIUM	1	130	10	0.018		
7440-41-7	BERYLLIUM	1	0.34	0.5	0.015	B	
7440-43-0	CADMIUM	1	2.2	0.5	0.017		
7440-70-2	CALCIUM	1	4100	100	0.54		
7440-47-3	CHROMIUM	1	7.3	1	0.048		
7440-48-4	COBALT	1	2.9	1	0.05		
7440-50-8	COPPER	1	21	1	0.032		
7439-99-6	IRON	1	7700	10	0.8		
7439-02-1	LEAD	1	620	0.3	0.14		
7439-95-4	MAGNESIUM	1	1200	100	0.79		
7439-96-6	MANGANESE	1	160	1	0.025		
7440-02-0	NICKEL	1	5.2	2	0.078		
7440-09-7	POTASSIUM	1	920	100	5.3		
7782-49-2	SELENIUM	1	0.38	0.5	0.27	B	
7440-22-4	SILVER	1	0.16	1	0.063	B	
7440-23-5	SODIUM	1	160	100	0.25		
7440-28-0	THALLIUM	1	1	1	0.39	U	
7440-02-2	VANADIUM	1	10	1	0.033		
7440-66-6	ZINC	1	300	2	0.29		

Data Package ID: IT0010156-1

Date Printed: Tuesday, October 24, 2006

Paragon Analytics Inc.

(JMS Version: 1.602)

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# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.

Work Order Number: 0010156

Client Name: Morrison Knudsen Corporation

Client Project ID: VB/I-7D IIB 4994

Field ID: 3-15627-F

Lab ID: 0010156-4

Sample Matrix: SOIL

% Moisture: 0.5

Date Collected: 19-Oct-00

Date Extracted: 23-Oct-00

Date Analyzed: 23-Oct-00

Prep Batch: IP001023-1

QC Batch ID: IP001023-1-1

Run ID: IT001023-1A4

Cleanup: NONE

Basis: Dry Weight

Sample Aliquot: 1 G

Final Volume: 100 ML

Result Units: MG/KG

File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7429-90-5	ALUMINUM	1	7000	20	0.69		
7440-38-0	ANTIMONY	1	1.6	2	0.27	B	
7440-38-2	ARSENIC	1	19	1	0.28		
7440-39-3	BARIUM	1	200	10	0.018		
7440-41-7	BERYLLIUM	1	0.71	0.5	0.015		
7440-43-0	CADMIUM	1	5.4	0.5	0.017		
7440-70-2	CALCIUM	1	6500	100	0.54		
7440-47-3	CHROMIUM	1	21	1	0.048		
7440-48-4	COBALT	1	6.4	1	0.05		
7440-50-8	COPPER	1	71	1	0.032		
7439-89-6	IRON	1	16000	10	0.8		
7439-92-1	LEAD	1	700	0.3	0.14		
7439-95-4	MAGNESIUM	1	2400	100	0.79		
7439-96-5	MANGANESE	1	360	1	0.025		
7440-02-0	NICKEL	1	12	2	0.078		
7440-09-7	POTASSIUM	1	2500	100	5.3		
7732-49-2	SELENIUM	1	1	0.5	0.27		
7440-22-4	SILVER	1	0.68	1	0.063	B	
7440-23-5	SODIUM	1	260	100	0.25		
7440-28-0	THALLIUM	1	1	1	0.39	U	
7440-62-2	VANADIUM	1	24	1	0.033		
7440-66-6	ZINC	1	620	2	0.29		

Data Package ID: IT0010156-1

Date Printed: Tuesday, October 24, 2000

Paragon Analytics Inc.

UIC Version: 1.902

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# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.

Work Order Number: 0010156

Client Name: Morrison Knudsen Corporation

Client/Project ID: VB/I-70 III 8 4994

Final ID: 13-15629-F  
Lab ID: 0010156-S

Sample Matrix: SOIL

% Moisture: 0.4

Date Collected: 19-Oct-00

Date Extracted: 23-Oct-00

Date Analyzed: 23-Oct-00

Prep Batch: IP001023-1

QC Batch ID: IP001023-1-1

Run ID: IT001023-1A4

Cleanup: NONE

Basis: Dry Weight

Sample Aliquot: 1 G

Final Volume: 100 ML

Result Units: MG/KG

File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7429-00-5	ALUMINUM	1	7500	20	0.69		
7440-36-0	ANTIMONY	1	1.6	2	0.27	B	
7440-38-2	ARSENIC	1	18	1	0.28		
7440-39-3	BARIUM	1	310	10	0.018		
7440-41-7	BERYLLIUM	1	0.73	0.5	0.015		
7440-43-9	CADMIUM	1	5.5	0.5	0.017		
7440-70-2	CALCIUM	1	6600	100	0.54		
7440-47-3	CHROMIUM	1	21	1	0.048		
7440-48-1	COBALT	1	6.5	1	0.05		
7440-50-8	COPPER	1	63	1	0.032		
7439-89-6	IRON	1	17000	10	0.8		
7439-92-1	LEAD	1	710	0.3	0.14		
7439-05-4	MAGNESIUM	1	2500	100	0.79		
7439-96-5	MANGANESE	1	400	1	0.025		
7440-02-0	NICKEL	1	12	2	0.078		
7440-09-7	POTASSIUM	1	2700	100	5.3		
7782-49-2	SELENIUM	1	1.2	0.5	0.27		
7440-22-4	SILVER	1	0.09	1	0.063	B	
7440-23-5	SODIUM	1	270	100	0.25		
7440-28-0	THALLIUM	1	1	1	0.39	U	
7440-52-2	VANADIUM	1	24	1	0.033		
7440-66-6	ZINC	1	820	2	0.29		

Data Package ID: 170010156-1

Date Printed: Tuesday, October 24, 2000

Paragon Analytics Inc.

LMS Version: 1.932

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# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.

Work Order Number: 0010156

Client Name: Morrison Knudsen Corporation

Client/Project ID: V81-70 IIB 4994

Field ID: 3-15630-F  
Lab ID: 0010156-6

Sample Matrix: SOIL  
% Moisture: 0.2  
Date Collected: 19-Oct-00  
Date Extracted: 23-Oct-00  
Date Analyzed: 23-Oct-00

Prep Batch: IP001023-1  
QC Batch ID: IP001023-1-1  
Run ID: IT001023-1A4  
Cleanup: NONE  
Basis: Dry Weight

Sample Aliquot: 1 G  
Final Volume: 100 ML  
Result Units: MG/KG

File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7429-90-5	ALUMINUM	1	8000	20	0.69		
7440-36-0	ANTIMONY	1	1.8	2	0.26	B	
7440-38-2	ARSENIC	1	20	1	0.28		
7440-39-3	BARIUM	1	310	10	0.018		
7440-41-7	BERYLLIUM	1	0.77	0.5	0.015		
7440-43-8	CADMIUM	1	5.7	0.5	0.017		
7440-70-2	CALCIUM	1	7000	100	0.54		
7440-47-3	CHROMIUM	1	21	1	0.047		
7440-48-4	COBALT	1	6.8	1	0.05		
7440-50-8	COPPER	1	64	1	0.032		
7439-89-8	IRON	1	18000	10	0.8		
7439-92-1	LEAD	1	760	0.3	0.14		
7439-95-4	MAGNESIUM	1	2700	100	0.79		
7439-98-5	MANGANESE	1	410	1	0.025		
7440-02-0	NICKEL	1	13	2	0.078		
7440-09-7	POTASSIUM	1	2900	100	5.3		
7782-49-2	SELENIUM	1	0.87	0.5	0.27		
7440-22-4	SILVER	1	0.77	1	0.063	B	
7440-23-5	SODIUM	1	300	100	0.25		
7440-28-0	THALLIUM	1	1	1	0.38	U	
7440-62-2	VANADIUM	1	26	1	0.033		
7440-68-6	ZINC	1	650	2	0.29		

Data Package ID: IT0010156-1

Date Printed: Tuesday, October 24, 2000

Paragon Analytics Inc.  
LIMS Version: 1.602

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# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.  
Work Order Number: 0010156  
Client Name: Morrison Knudsen Corporation  
Client/Project ID: VB/1-70 IIB 4994

Field ID: 3-15703-B  
Lab ID: 0010156-7

Sample Matrix: SOIL  
% Moisture: 0.2  
Date Collected: 19-Oct-00  
Date Extracted: 23-Oct-00  
Date Analyzed: 23-Oct-00

Prep Batch: IP001023-1  
QC Batch ID: IP001023-1-1  
Run ID: IT001023-1A4  
Cleanup: NONE  
Basis: Dry Weight

Sample Aliquot: 1 G  
Final Volume: 100 ML  
Result Units: MG/KG  
File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7429-90-5	ALUMINUM	1	2600	20	0.69		
7440-36-0	ANTIMONY	1	1.5	2	0.26	B	
7440-38-2	ARSENIC	1	0.8	1	0.28		
7440-33-3	BARIUM	1	160	10	0.018		
7440-41-7	BERYLLIUM	1	0.31	0.5	0.015	B	
7440-43-9	CADMIUM	1	2.1	0.5	0.017		
7440-70-2	CALCIUM	1	3000	100	0.54		
7440-47-3	CHROMIUM	1	9.1	1	0.047		
7440-48-1	COBALT	1	2.9	1	0.05		
7440-50-8	COPPER	1	22	1	0.032		
7439-89-6	IRON	1	6600	10	0.8		
7439-92-1	LEAD	1	900	0.3	0.14		
7439-95-4	MAGNESIUM	1	790	100	0.79		
7439-96-5	MANGANESE	1	270	1	0.025		
7440-02-0	NICKEL	1	4.4	2	0.078		
7440-09-7	POTASSIUM	1	860	100	5.3		
7782-40-2	SELENIUM	1	0.39	0.5	0.27	B	
7440-22-4	SILVER	1	0.17	1	0.063	B	
7440-23-5	SODIUM	1	120	100	0.25		
7440-28-0	THALLIUM	1	1	1	0.39	U	
7440-62-2	VANADIUM	1	11	1	0.033		
7440-66-6	ZINC	1	400	2	0.29		

Data Package ID: IT0010156-1

Date Printed: Tuesday, October 24, 2000

Paragon Analytics Inc.

LIMS Version: 1.002

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# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.  
Work Order Number: 0010156  
Client Name: Morrison Knudsen Corporation  
Client/Project ID: VBA-70 IIB 4994

Field ID: 3-15704-9  
Lab ID: 0010156-8

Sample Matrix: SOIL  
% Moisture: 0.3  
Date Collected: 19-Oct-00  
Date Extracted: 23-Oct-00  
Date Analyzed: 23-Oct-00

Prep Batch: IP001023-1  
QC Batch ID: IP001023-1-1  
Run ID: IT001023-1A4  
Cleanup: NONE  
Basis: Dry Weight

Sample Aliquot: 1 G  
Final Volume: 100 ML  
Result Units: MG/KG  
File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7429-90-5	ALUMINUM	1	2200	20	0.69		
7440-36-0	ANTIMONY	1	0.67	2	0.26	B	
7410-38-2	ARSENIC	1	0.1	1	0.28		
7440-39-3	BARIUM	1	100	10	0.018		
7440-41-7	BERYLLIUM	1	0.3	0.5	0.015	B	
7440-43-8	CADMIUM	1	1.8	0.5	0.017		
7440-70-2	CALCIUM	1	2900	100	0.54		
7440-47-3	CHROMIUM	1	7.9	1	0.048		
7440-48-4	COBALT	1	2.3	1	0.05		
7440-50-8	COPPER	1	20	1	0.032		
7439-98-6	IRON	1	6400	10	0.8		
7439-92-1	LEAD	1	370	0.3	0.14		
7439-95-4	MAGNESIUM	1	750	100	0.79		
7439-96-5	MANGANESE	1	190	1	0.025		
7440-02-0	NICKEL	1	3.7	2	0.078		
7440-09-7	POTASSIUM	1	750	100	5.3		
7782-49-2	SELENIUM	1	0.5	0.5	0.27	U	
7440-22-4	SILVER	1	0.17	1	0.063	B	
7440-23-5	SODIUM	1	76	100	0.25	B	
7440-28-0	THALLIUM	1	1	1	0.39	U	
7440-62-2	VANADIUM	1	8.2	1	0.033		
7440-66-6	ZINC	1	240	2	0.29		

Data Package ID: IT0010156-1

Date Printed: Tuesday, October 24, 2000

Paragon Analytics Inc.

LMG Version: 1.002

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# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.  
Work Order Number: 0010156  
Client Name: Morrison Knudsen Corporation  
Client/Project ID: VB/I-70 IIB 4994

Field ID: 3-15705-B  
Lab ID: 0010156-9

Sample Matrix: SOIL  
% Moisture: 0.1  
Date Collected: 19-Oct-00  
Date Extracted: 23-Oct-00  
Date Analyzed: 23-Oct-00

Prep Batch: IP001023-1  
QCBatchID: IP001023-1-1  
Run ID: IT001023-1A4  
Cleanup: NONE  
Basis: Dry Weight

Sample Aliquot: 1 G  
Final Volume: 100 ML  
Result Units: MG/KG  
File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7429-90-5	ALUMINUM	1	2500	20	0.69		
7440-36-0	ANTIMONY	1	1	2	0.26	B	
7440-38-2	ARSENIC	1	9.8	1	0.28		
7440-39-3	BARIUM	1	130	10	0.018		
7440-41-7	BERYLLIUM	1	0.31	0.5	0.015	B	
7440-43-9	CADMIUM	1	1.9	0.5	0.017		
7440-70-2	CALCIUM	1	3100	100	0.53		
7440-47-3	CHROMIUM	1	9.7	1	0.047		
7440-48-4	COBALT	1	4	1	0.05		
7440-50-8	COPPER	1	28	1	0.032		
7439-89-6	IRON	1	8000	10	0.8		
7439-92-1	LEAD	1	400	0.3	0.14		
7439-95-4	MAGNESIUM	1	780	100	0.79		
7439-96-5	MANGANESE	1	260	1	0.026		
7440-02-0	NICKEL	1	4.2	2	0.078		
7440-09-7	POTASSIUM	1	950	100	5.3		
7782-49-2	SELENIUM	1	0.31	0.5	0.27	B	
7440-22-4	SILVER	1	0.38	1	0.063	B	
7440-23-5	SODIUM	1	88	100	0.25	B	
7440-26-0	THALLIUM	1	1	1	0.39	U	
7440-62-2	VANADIUM	1	93	1	0.033		
7440-66-6	ZINC	1	320	2	0.29		

Data Package ID: IT0010156-1

Date Printed: Tuesday, October 24, 2000

Paragon Analytics Inc.

LIMS Version: 1.802

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# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.

Work Order Number: 0010156

Client Name: Morrison Knudsen Corporation

Client Project ID: VB/I-70 IIB 4894

Field ID: 3-15700-F

Lab ID: 0010156-10

Sample Matrix: SOIL

% Moisture: 0.3

Date Collected: 19-Oct-00

Date Extracted: 23-Oct-00

Date Analyzed: 23-Oct-00

Prep Batch: IP001023-1

QC Batch ID: IP001023-1-1

Run ID: IT001023-1A4

Cleanup: NONE

Basis: Dry Weight

Sample Aliquot: 1 G

Final Volume: 100 ML

Result Units: MG/KG

File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7429-90-5	ALUMINUM	1	5900	20	0.69		
7440-36-0	ANTIMONY	1	2.3	2	0.26		
7440-38-2	ARSENIC	1	26	1	0.28		
7440-39-3	BARIUM	1	200	10	0.018		
7440-41-7	BERYLLIUM	1	0.66	0.5	0.015		
7440-43-9	CADMIUM	1	4.2	0.5	0.017		
7440-70-2	CALCIUM	1	6200	100	0.54		
7440-47-3	CHROMIUM	1	21	1	0.048		
7440-48-4	COBALT	1	5.5	1	0.05		
7440-50-8	COPPER	1	54	1	0.032		
7439-89-6	IRON	1	16000	10	0.8		
7439-92-1	LEAD	1	970	0.3	0.14		
7439-95-4	MAGNESIUM	1	1800	100	0.79		
7439-96-5	MANGANESE	1	410	1	0.025		
7440-02-0	NICKEL	1	9.5	2	0.078		
7440-09-7	POTASSIUM	1	2000	100	5.3		
7782-49-2	SELENIUM	1	1	0.5	0.27		
7440-22-4	SILVER	1	0.81	1	0.063	B	
7440-23-5	SODIUM	1	180	100	0.25		
7440-23-0	THALLIUM	1	1	1	0.39	U	
7440-62-2	VANADIUM	1	23	1	0.033		
7440-66-6	ZINC	1	540	2	0.29		

Data Package ID: IT0010156-1

Date Printed: Tuesday, October 24, 2000

Paragon Analytics Inc.

UNIS Version 1.002

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# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.

Work Order Number: 0010156

Client Name: Morrison Knudsen Corporation

Client/Project ID: V01-70 IIB 4994

Field ID: 3-15701-F  
Lab ID: 0010156-11

Sample Matrix: SOIL

% Moisture: 0.2

Date Collected: 19-Oct-00

Date Extracted: 23-Oct-00

Date Analyzed: 23-Oct-00

Prep Batch: IP001023-1

QC Batch ID: IP001023-1-1

Run ID: IT001023-1A4

Cleanup: NONE

Basis: Dry Weight

Sample Aliquot: 1 G

Final Volume: 100 ML

Result Units: MG/KG

File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7429-90-5	ALUMINUM	1	6100	20	0.69		
7440-35-0	ANTIMONY	1	2	2	0.26	B	N
7440-38-2	ARSENIC	1	25	1	0.28		
7440-39-3	BARIUM	1	300	10	0.018		
7440-41-7	BERYLLIUM	1	0.67	0.5	0.015		
7440-43-9	CADMIUM	1	4.3	0.5	0.017		
7440-70-2	CALCIUM	1	6200	100	0.54		
7440-47-3	CHROMIUM	1	21	1	0.047		
7440-48-4	COBALT	1	5.5	1	0.05		
7440-50-8	COPPER	1	54	1	0.032		
7439-69-6	IRON	1	16000	10	0.8		
7439-92-1	LEAD	10	1000	3	1.4		
7439-95-4	MAGNESIUM	1	1800	100	0.79		
7439-96-5	MANGANESE	1	430	1	0.025		
7440-02-0	NICKEL	1	9.6	2	0.078		
7440-08-7	POTASSIUM	1	2000	100	5.3		
7762-49-2	SELENIUM	1	1.1	0.5	0.27		
7440-22-4	SILVER	1	0.77	1	0.063	B	
7440-23-5	SODIUM	1	160	100	0.25		E
7440-28-0	THALLIUM	1	1	1	0.39	U	
7440-62-2	VANADIUM	1	23	1	0.033		
7440-66-6	ZINC	1	550	2	0.29		

Data Package ID: IT0010156-1

Date Printed: Tuesday, October 24, 2000

Paragon Analytics Inc.

LIMS Version 1.022

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# Total ICP Metals

Method SW6010

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.

Work Order Number: 0010156

Client Name: Morrison Knudsen Corporation

Client Project ID: VB/J-70 IIB 4994

Field ID: 3-15702-JF  
Lab ID: 0010156-12

Sample Matrix: SOIL

% Moisture: 0.3

Date Collected: 19-Oct-00

Date Extracted: 23-Oct-00

Date Analyzed: 23-Oct-00

Prop Batch: IP001023-1

QC Batch ID: IP001023-1-1

Run ID: IT001023-1A4

Cleanup: NONE

Basis: Dry Weight

Sample Aliquot: 1 G

Final Volume: 100 ML

Result Units: MG/KG

File Name: TS01023

CASNO	Target Analyte	Dilution Factor	Result	Reporting Limit	MDL	Result Qualifier	EPA Qualifier
7429-90-8	ALUMINUM	1	6500	20	0.69		
7440-38-0	ANTIMONY	1	0.91	2	0.26	B	
7440-38-2	ARSENIC	1	24	1	0.28		
7440-39-3	BARIUM	1	290	10	0.018		
7440-41-7	BERYLLIUM	1	0.61	0.5	0.015		
7440-43-0	CADMIUM	1	4.2	0.5	0.017		
7440-70-2	CALCIUM	1	6100	100	0.54		
7440-47-3	CHROMIUM	1	18	1	0.048		
7440-48-1	COBALT	1	4.6	1	0.05		
7440-50-8	COPPER	1	50	1	0.032		
7439-89-8	IRON	1	11000	10	0.8		
7439-92-1	LEAD	1	990	0.3	0.14		
7439-95-4	MAGNESIUM	1	1700	100	0.79		
7439-96-5	MANGANESE	1	400	1	0.025		
7440-02-0	NICKEL	1	8.4	2	0.078		
7440-09-7	POTASSIUM	1	2100	100	5.3		
7762-48-2	SELENIUM	1	1.2	0.5	0.27		
7440-22-4	SILVER	1	0.61	1	0.053	B	
7440-23-5	SODIUM	1	180	100	0.25		
7440-28-0	THALLIUM	1	1	1	0.39	U	
7440-62-2	VANADIUM	1	16	1	0.033		
7440-66-6	ZINC	1	540	2	0.29		

Data Package ID: IT0010156-1

Date Printed: Tuesday, October 24, 2000

Paragon Analytics Inc.

LIMS Version: 1.003

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# Total MERCURY

Method SW7471

Sample Results

PRELIMINARY RESULTS

Lab Name: Paragon Analytics, Inc.  
Client Name: Morrison Knudsen Corporation  
Client Project ID: VB/1-70 IIB 4984  
Work Order Number: 0010156  
Reporting Basis: Dry Weight

Final Volume: 100 ML  
Matrix: SOIL  
Result Units: MG/KG

Client Sample ID	Lab ID	Date Collected	Date Prepared	Date Analyzed	Percent Moisture	Dilution Factor	Result	Reporting Limit	MDL	Flag	Sample Aliquot
3-15023-B	0010156-1	10/19/2000	10/23/2000	10/23/2000	0.2	1	0.63	0.1	0.0028		.6 G
3-15023-B	0010156-2	10/19/2000	10/23/2000	10/23/2000	0.2	1	0.59	0.1	0.0028		.6 G
3-15024-B	0010156-3	10/19/2000	10/23/2000	10/23/2000	0.5	1	0.68	0.1	0.0028		.6 G
3-15027-F	0010156-4	10/19/2000	10/23/2000	10/23/2000	0.5	1	1.0	0.1	0.0028		.6 G
3-15079-F	0010156-5	10/19/2000	10/23/2000	10/23/2000	0.4	1	1.6	0.1	0.0028		.6 G
3-15030-F	0010156-6	10/19/2000	10/23/2000	10/23/2000	0.2	2 / 1.8	0.2	0.1	0.0028		.6 G
3-15703-B	0010156-7	10/19/2000	10/23/2000	10/23/2000	0.2	1	0.22	0.1	0.0028		.6 G
3-15704-B	0010156-8	10/19/2000	10/23/2000	10/23/2000	0.3	1	0.25	0.1	0.0028		.6 G
3-15705-B	0010156-9	10/19/2000	10/23/2000	10/23/2000	0.1	1	0.23	0.1	0.0028		.6 G
3-15700-F	0010156-10	10/19/2000	10/23/2000	10/23/2000	0.3	1	0.6	0.1	0.0028		.6 G
3-15701-F	0010156-11	10/19/2000	10/23/2000	10/23/2000	0.2	1	0.56	0.1	0.0028	N	.6 G
3-15702-F	0010156-12	10/19/2000	10/23/2000	10/23/2000	0.3	1	0.68	0.1	0.0028		.6 G

## Comments:

1, ND or U = Not Detected at or above the client requested detection limit.

Data Package ID: HG0010156-1

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Paragon Analytics Inc.

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